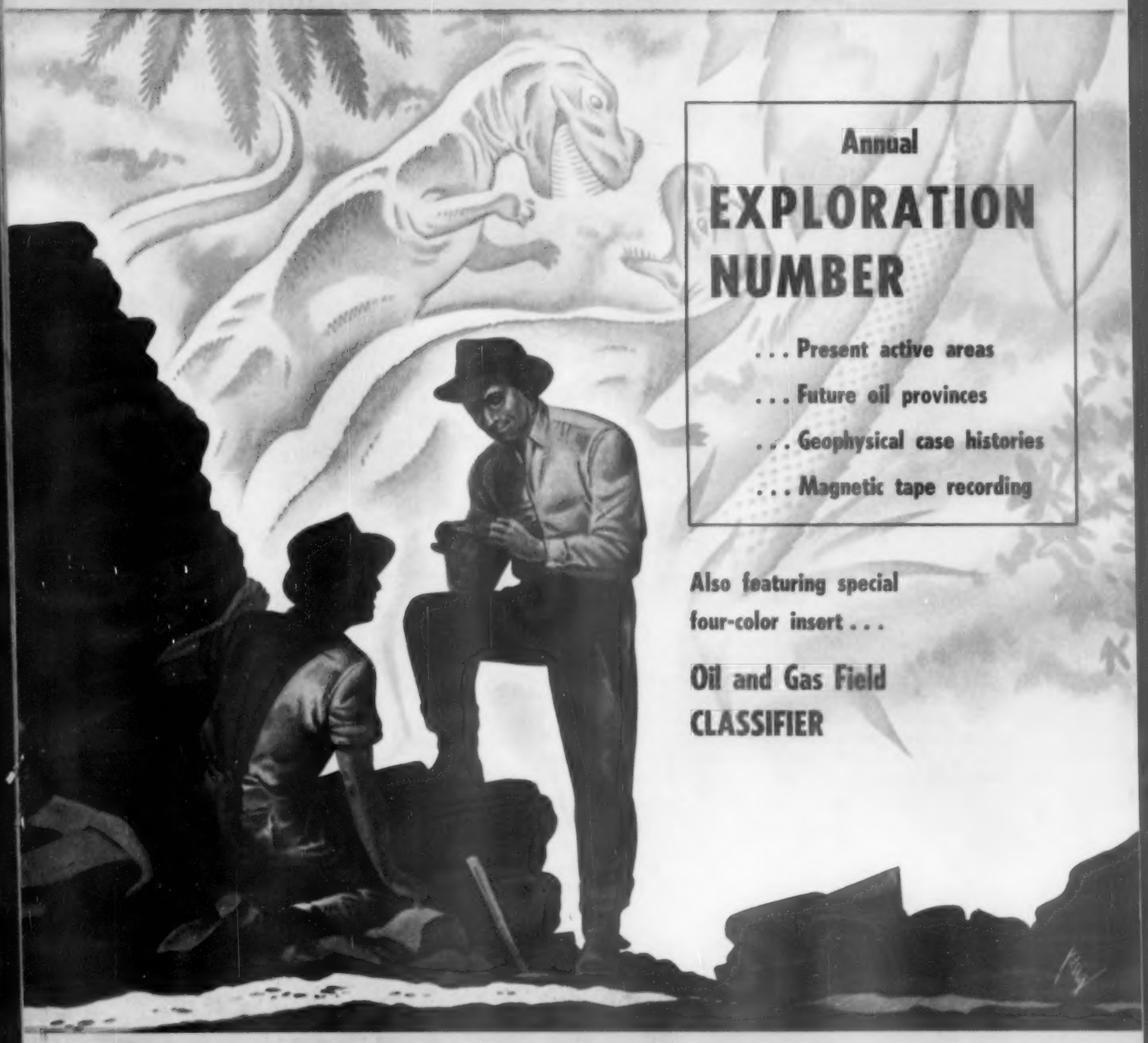
APRIL 4, 1955

the OIL AND GAS JOURNAL



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. . . Future oil provinces

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- Cracking the Octane Barrier—With Rexforming . 98
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PAGE 1 ONE . . . a glance ahead

Canada will make it easier for its producers to export gas to the United States. At present an export license is required, and Canadian officials can revoke this license or vary the amount of export duty at will. This makes it impossible for a pipeline company to prove a firm, long-term supply of gas which, in turn, is required by the Federal Power Commission for a line serving cities in the U.S. A bill has been introduced in Parliament which would trim Canadian officials' powers and give greater assurance of a firm gas supply.

Another Canadian question of concern on both sides of the border is what to do about Canadian crude as the supply climbs during the next 5 years. Many dominion officials favor supplying the Canadian market 100 per cent with domestic supplies, regardless of cost. Operators generally favor a plan which would mean continued imports into eastern Canada and a steady expansion of exports to the United States. A lot of politics will be involved before the course is finally set.

Granting of new concessions in Venezuela is expected by most operators in the near future. The principal reason: Venezuela needs additional revenue to support large-scale spending programs.

Many refiners are giving special attention to better relations with jobbers and dealers. In some areas dealer turnover is running 35 per cent or more a year. A dealer change costs a refiner a minimum of $1,000. This unsatisfactory situation is also directly connected with price wars, which result in lower refinery realizations.

Look for greatly increased use of corrosion inhibitors in refining operations. These materials have been used for some time in pipelining and production operations. Plant-scale tests are now showing their value to the refiner.

Admixture, a fancy name for "shrinkage," is finally going to be studied by an official A.P.I. technical group. When 5 bbl. of light material is added to 100 bbl. of heavy crude or product, the result, instead of 105 bbl., is something less. Correction factors for this shrinkage vary widely throughout the pipeline industry. The study should come up with some standard correction tables.

The OIL AND GAS JOURNAL

APRIL 4, 1955 • VOLUME 53 • NUMBER 48

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Refiner's Notebook 240

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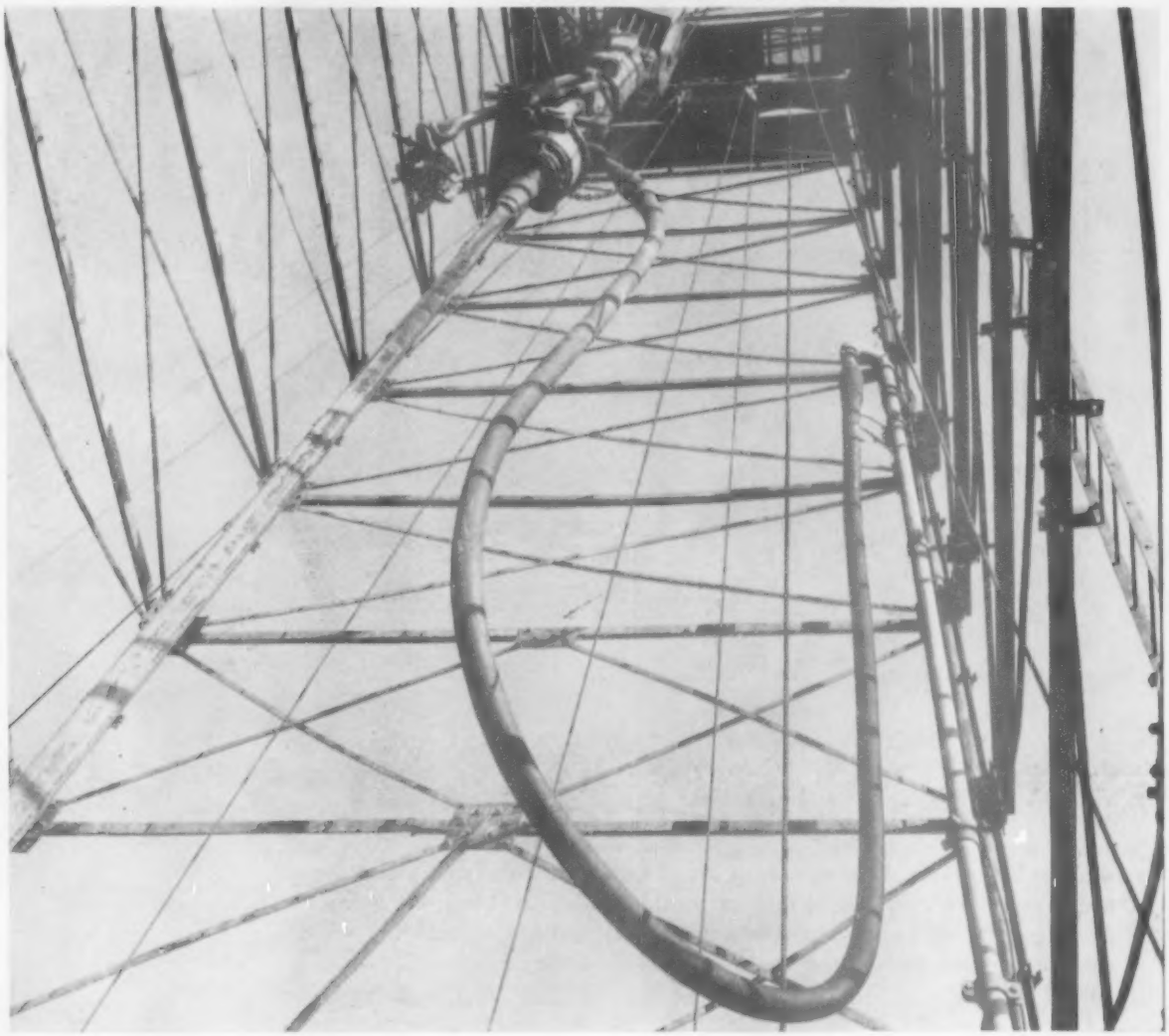

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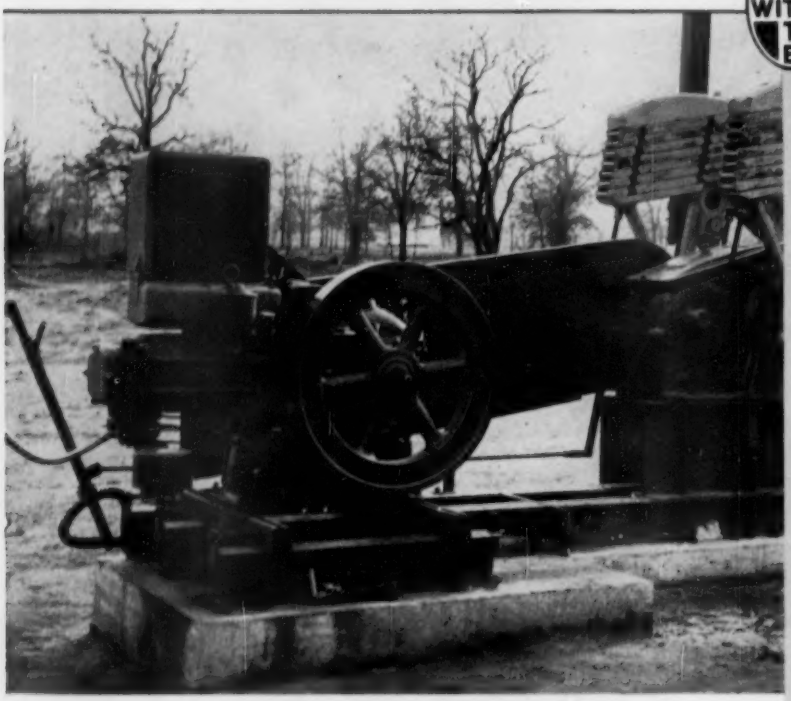
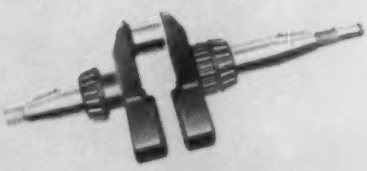


Replaceable, wet-type cylinder liner can be easily installed in the field.

Cylinder head has large gas passages and is fitted with replaceable, alloy seat inserts and valve guides.

Piston is precision ground and fitted with four compression rings and two oil rings.



Crankshaft is of heat-treated, forged steel, counter balanced, and mounted in shim-adjustable tapered roller bearings.

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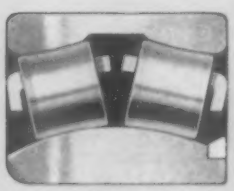

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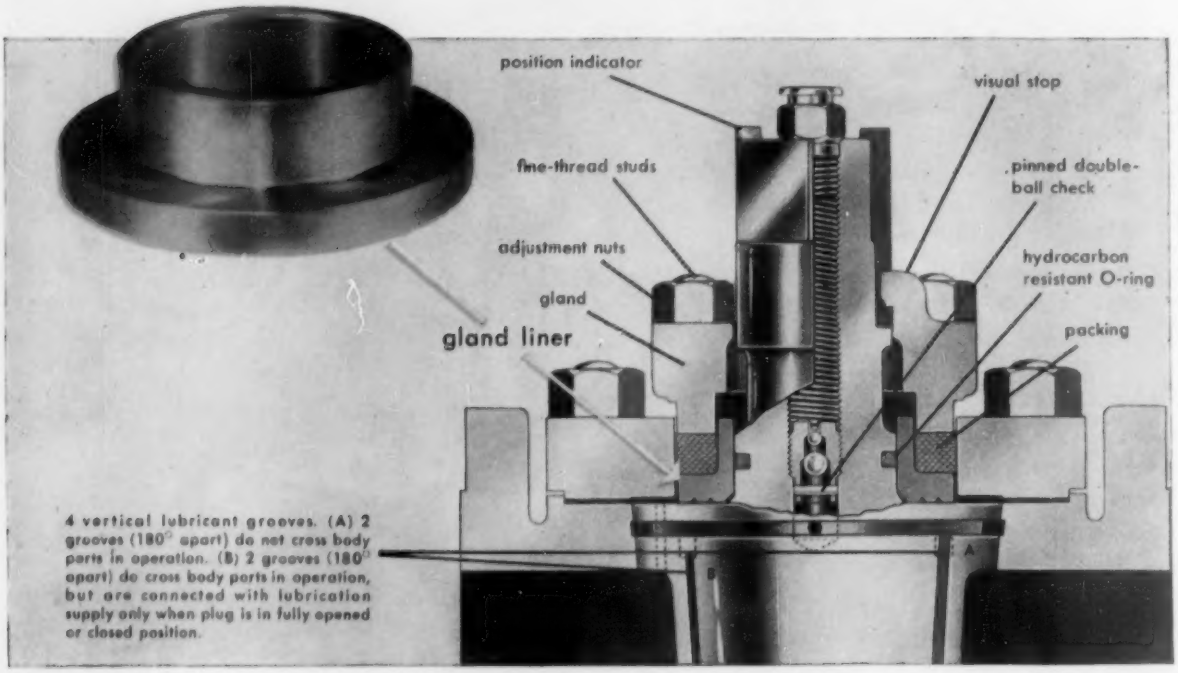
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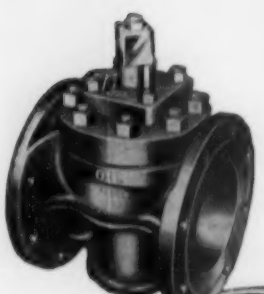

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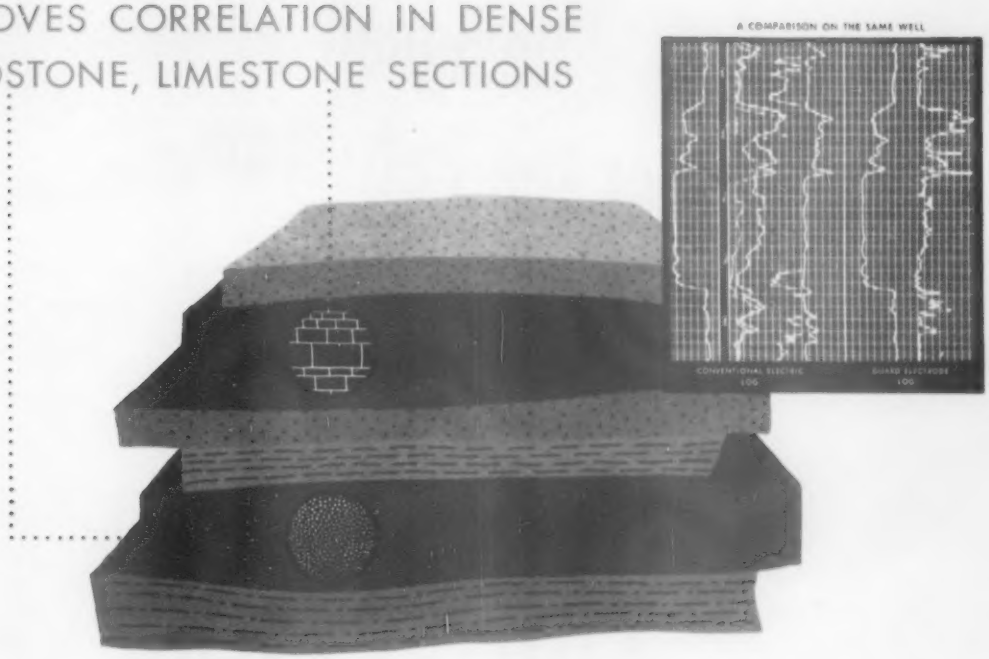

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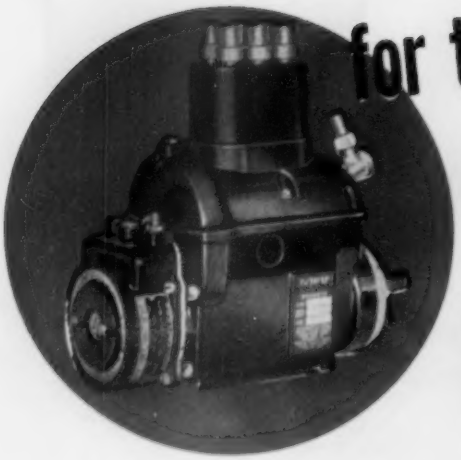

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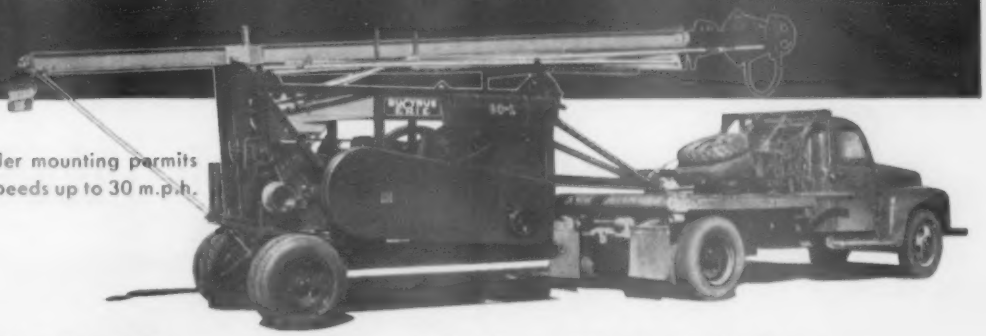
Kilgore • Wichita Falls • Casper, Wyoming • Great Bend, Kansas • Effingham, Illinois • Duncan, Oklahoma
Brookhaven, Mississippi • El Dorado, Arkansas

Lufkin equipment in Canada is handled by THE LUFKIN MACHINE CO., LTD., 14321 108th Avenue, EDMONTON, ALBERTA, CANADA

Putting New Meaning Into Mobility



This semi-trailer mounting permits traveling at speeds up to 30 m.p.h.

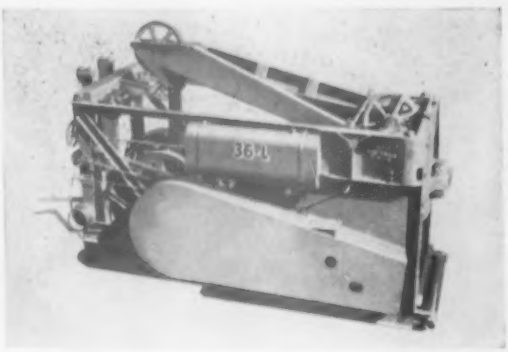
With Bucyrus-Erie Spudders

With Bucyrus-Erie spudders, mobility means more than mere "travel-ability". It means really fast tear downs, speedy moves, and quick setups on new locations — all can be done in hours with as few as two or three men.

The secret of the moving speed of Bucyrus-Erie spudders lies in their sturdy, compact construction, all-round balance, telescoping derricks, and a choice of three efficient mountings—semi-trailer, tandem axle or skid. These features combine to give you spudders that really "get around", cutting idle-rig time to a bare minimum, and allowing more time for actual drilling.

Speed is the keynote of drilling with Bucyrus-Erie spudders, too. The extra footage derived from a dependable direct-drive drilling motion means still more profits on your drilling jobs. Investigate these spudders now — they're your key to extra profits. See your nearby Bucyrus-Erie spudder distributor for complete information.

3554



The skid-type mounting, an integral part of the all-steel frame, slides easily on and off trucks, derrick floors, or mudboats.

Compactly built tandem axle mountings give added mobility to the larger 36-L and 48-L spudders.

BUCYRUS ERIE

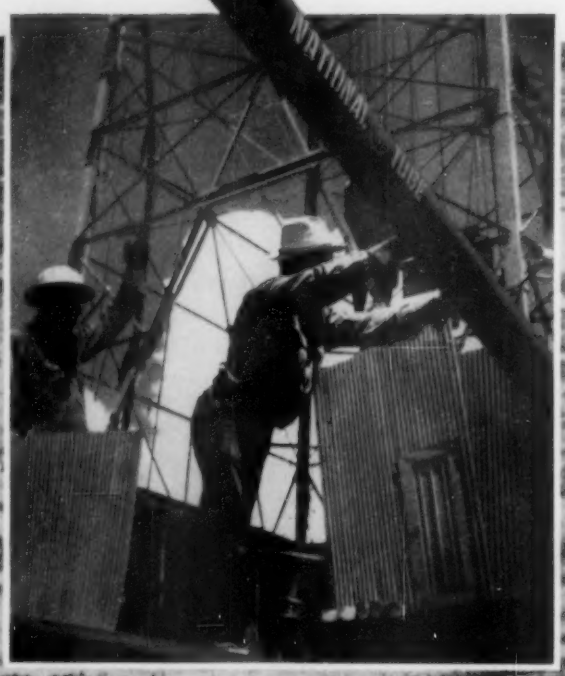
South Milwaukee, Wisconsin

FIRST with the FINEST in Spudders

Another Record-Breaker for

Deepest producer on

does the job



All National Drill Pipe, Casing, and Tubing is pierced from solid billets of high quality steel — the one manufacturing method that assures absolutely uniform wall strength.

NATIONAL SEAMLESS...

Grande Ecaille Dome

with NATIONAL Drill Pipe, Casing, and Tubing

The L.L.&E. #1, a 16,281-foot John W. Mecom-Freeport Sulphur Well in Lake Washington Field, Plaquemines Parish, Louisiana, is the deepest producer on the Grande Ecaille Dome. On a four-hour production test, the well flowed at the rate of 405 barrels of 48-9-gravity condensate daily through a small choke. It made gas at the rate of 1,325,000 cubic feet.

NATIONAL Seamless Drill Pipe was used in drilling the new well to a depth of 16,281 feet, before completion was made. The combination casing string consisted of 5700 feet of 7-inch O.D. NATIONAL (B) Buttress-Thread Casing, 9300 feet of 7-inch O.D. NATIONAL Deep Well Casing, and 1425 feet of NATIONAL N-80 Liner. The 16,257 feet of tubing were NATIONAL Seamless. All tubing in the hole passed Loomis testing during running.

NATIONAL Seamless Oil Country Tubular Products are habitually chosen for the *deep* hole jobs because they promise trouble-free dependability all the way down—even under the most rigorous conditions. The Seamless process of manufacture gives them unsurpassed uniformity and strength, the best defense against fatigue, twisting action, and collapse.

Look at these National Tube developments for the Oil Industry:

NATIONAL DEOXIDIZED BESSEMER STEEL CASING AND TUBING...GRADES H-40, J-55
Especially well-suited for oil production because of its combination of high yield strength and good ductility.

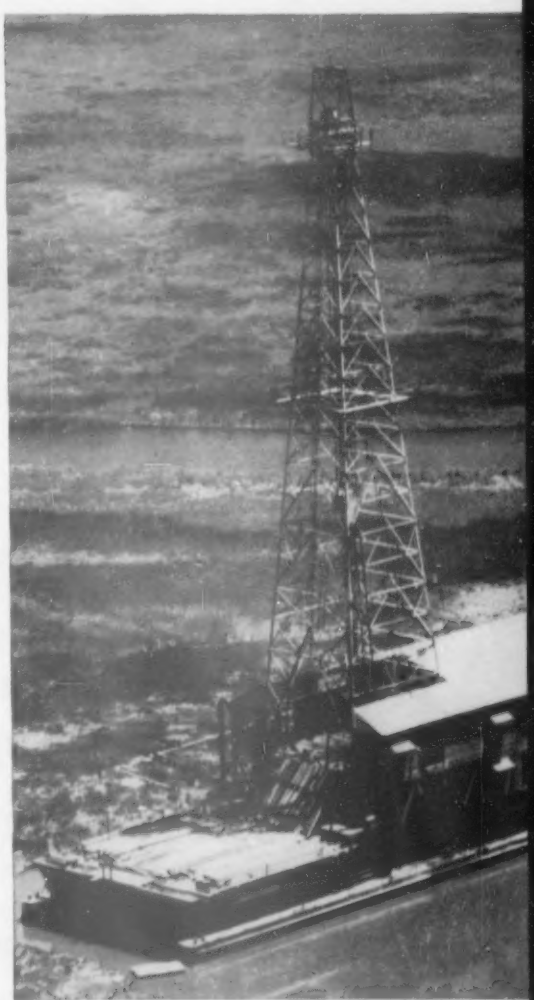
NATIONAL WARM-WORKED CASING . . . GRADE N-80
An extremely high strength casing possessing a uniformity of physical properties which gives it high collapse resistance and greatly increased joint strength, hydrostatically tested to 80% of minimum yield strength up to a maximum of 10,000 p.s.i.

NATIONAL DEEP-WELL CASING
A stronger casing than is provided under A.P.I. specifications, to meet constantly increasing depths. Because it is intended for severe service it is hydrostatically tested to 80% of minimum yield strength up to a maximum of 12,000 p.s.i.

NATIONAL (B) BUTTRESS THREAD-CASING
Developed to satisfy the need for a casing joint which will safely and economically support the weight of deep-well casing. The buttress-thread joint is comparable in strength to that of the body of the pipe.

For complete details on NATIONAL Seamless Drill Pipe, Casing and Tubing, write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

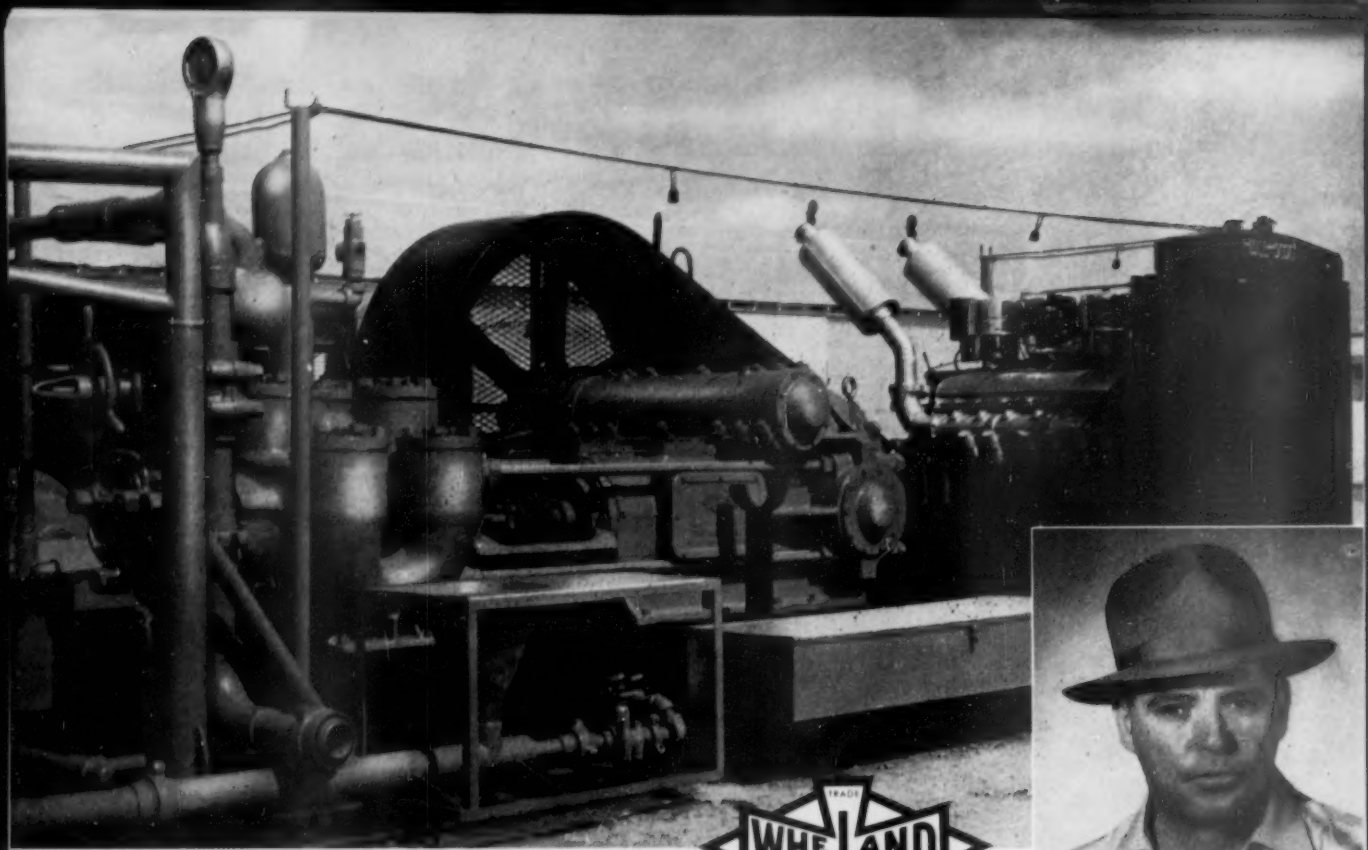


SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

NATIONAL (USS) SEAMLESS

DRILL PIPE . . . CASING . . . TUBING

UNITED STATES STEEL



Lucien Flournoy

"Well pleased with its performance... getting excellent service... recommend it highly....."

WHELAND

HP 14000 7½" x 14"

DUPLEX SLUSH PUMP

350 Horsepower

NOMINAL INPUT AT 60 R.P.M.

Discharge Pressure with 7½" liners 838 PSI
Discharge Pressure with 5½" liners 1627 PSI

WRITE FOR DETAILED BULLETIN

WHELAND

THE WHELAND COMPANY, CHATTANOOGA, TENN., U. S. A.

ROTARY DRILLING MACHINERY

DRAW WORKS • SLUSH PUMPS • ROTARIES
CROWN BLOCKS • TRAVELING BLOCKS • SWIVELS

DISTRIBUTORS

DOMESTIC: INDUSTRIAL SUPPLY COMPANY, INC.--Main Office: Wichita Falls, Texas • HOUSTON OIL FIELD MATERIAL COMPANY, INC.--Main Office: Houston, Texas • JONES AND LAUGHLIN STEEL CORPORATION, SUPPLY DIVISION--Main Office: Drawer 2481, Tulsa 2, Oklahoma.

EXPORT: LUCEY EXPORT CORPORATION--233 Broadway, New York 7, N. Y.--Broad Street House, London E. C. 2, England.

Flournoy Drilling Company
P O Box 1528 Telephone 4-4192
Alice, Texas

February 24, 1955

Mr. G. P. Street, President
The Wheland Company
Signal Mountain Road
Chattanooga, Tennessee

Dear Sir:

We know you are interested in the performance of the HP-14000 Pump we purchased from your company.

This pump has drilled a total of 55,781 feet and has been used on two 9,000 foot workovers with no lost rig time due to breakdown and has had no service repairs to date.

We have, on nine occasions, drilled better than 1,000 feet during one eight hour drilling tour. Our best drilling rate was 2,040 feet in 12-1/2 hours on the Gaddis Bros. No. 1, La Salle County, Texas. This record can readily be credited, in part, to the excellent performance of this pump.

At present, this pump is in operation near Premont, Texas. We are well pleased with its performance and are getting excellent service. We recommend it highly.

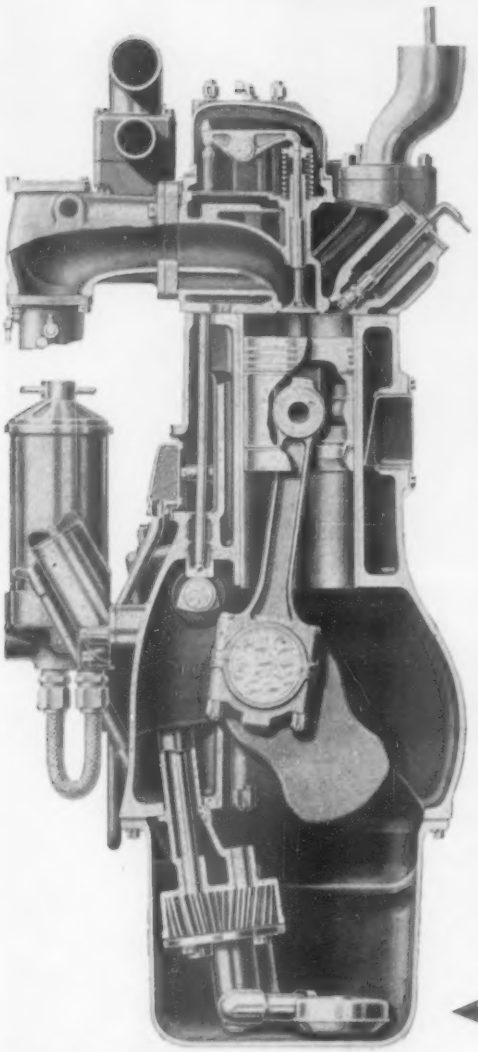
Yours very truly,

FLOURNOY DRILLING COMPANY

Lucien Flournoy
President

12 Solutions to Your Pumping Problems

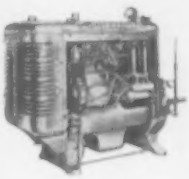
Insist on INTERNATIONAL as original equipment on your pumps; they're tops for power as replacements, too!



An example of the sturdy construction of INTERNATIONAL *oil field engines is seen in the cutaway front sectional view of the new U-1091.*

HERE ARE SOME of the many outstanding features of this INTERNATIONAL U-1091 natural gas engine: seven-bearing counterbalanced crankshaft, torsional vibration damper, aluminum-alloy pistons, tin-plated for scuff resistance, replaceable cylinder sleeves, intake and exhaust manifolds on opposite sides for free flow of air and gas into engine and unrestricted outflow of exhaust gases, stellite inserts on exhaust valve seats, and full-pressure lubrication.

INTERNATIONAL 4-CYLINDER OIL FIELD ENGINES



INTERNATIONAL U-264 engine is next to the largest in the 4-cylinder line with 264 cu. in. displacement and 29-52 horsepower range on the pumps.

SPECIFICATIONS

	DISP.	MAX. TORQUE @ RPM	RPM SPEED RANGE	HP RANGE
U-1	59.5	38@1700	1500-2500	8 to 16
U-2A	113	82@1200	1200-1800	15 to 24
U-164	164	124@1000	1000-1800	18 to 36
U-264	264	197@ 900	900-1600	29 to 52
U-9	334.5	229@ 950	900-1500	31 to 55

INTERNATIONAL 6-CYLINDER OIL FIELD ENGINES

INTERNATIONAL U-282 is one of seven new IH 6-cylinder oil field engines that have shown pumpers everywhere how to cut maintenance and operating costs.

SPECIFICATIONS

	DISP.	MAX. TORQUE @ RPM	RPM SPEED RANGE	HP RANGE
U-220	220.5	151@1200	1200-2400	30-62
U-240	240	166@1200	1200-2400	34-64
U-282	282.5	204@1225	1200-2400	41-75
U-372	372	263@1200	1200-2200	54-91
U-406	405.9	279@1200	1200-2200	56-98
U-450	450	324@1200	1200-2200	66-110
U-1091	1091.6	823@ 800	900-1600	136-200

The growing tendency to standardize on stand-out performers is adding to the reputation of INTERNATIONAL pumping engines throughout the oil fields.

The INTERNATIONAL line includes 12 models of 4-and-6-cylinder oil field engines, ranging from 38.5 to 823 lbs. ft. maximum torque—from 8 to 200 net horsepower.

If you need a full measure of honest power, IH is the line for the most exacting applications. Whether you need original equipment or replacement power, check with your INTERNATIONAL Industrial Power Unit Distributor or Dealer and discover how INTERNATIONALS can do your work better and for less money.

INTERNATIONAL INDUSTRIAL POWER

MAKES EVERY LOAD A PAYLOAD

INTERNATIONAL HARVESTER

INTERNATIONAL HARVESTER COMPANY, CHICAGO 1, ILLINOIS

an ACCO product

You asked for it...NOW...here it is!

NEW

TRU-LAY VHS

Very High Strength Wire Rope

Sets New Service Records as ROTARY DRILLING LINES

Tru-Lay VHS tops all past standards by 15%!

Drills Deeper—With stronger VHS you can drill to a greater depth before increasing the number of parts of line.

More Ton Miles per Foot of Rope—New VHS is not only stronger, it's tougher . . . has greater resistance to abrasion and wear. Because of this, operators can safely extend the Ton Miles between cuts . . . get more Ton Miles per foot of rope.

Better Spooling on Drums—Tougher VHS resists deformation . . . keeps its shape for longer periods of service.

Higher Factor of Safety—VHS's increased breaking strength means a higher factor of safety during the entire period of service.

New VHS adds greater strength and toughness to the advantages of Tru-Lay Preformed construction. It saves you money by increasing service life and reducing "down time" for drilling line replacements.

Ask at your nearby Mid-Continent Supply store or write to the nearest American Chain & Cable Company office listed at right for Brochure DH-489

ACCO

TRADE MARK

American Cable Division
AMERICAN CHAIN & CABLE

Plants: Houston, Tex., Wilkes-Barre, Pa.
Offices and warehouses: Odessa, Tex., San Francisco, Portland, Ore., Pittsburgh, Philadelphia, New York, Los Angeles, Denver, Chicago, Atlanta · Bridgeport, Conn.

VHS 15% STRONGER

THESE MIDWEST "LONG TANGENT" ELBOWS SAVED $4121 IN PIPE

MIDWEST "LONG TANGENT" ELBOWS COST NO MORE THAN OTHER ELBOWS

Here are 1227 Midwest "Long Tangent" Elbows (12", 14" and 16" standard weight) ready for shipment to a chemical plant. Each Midwest "Long Tangent" Elbow has a straight section on each end equal in length to ¼ the nominal pipe size. Thus a 12" elbow saves 6" of 12" pipe while a 16" elbow saves 8" of 16" pipe. It doesn't take long to save a lot of pipe and a lot of money . . . in this instance $4121.

But saving pipe is not the only advantage of Midwest "Long Tangent" Elbows. They often eliminate short nipples and their extra welds . . . save time and money in lining up and clamping pipe and fittings . . . slip-on flanges are more easily applied. For all the facts, write for Catalog 54.

MIDWEST PIPING COMPANY, INC.
Main Office: 1450 South Second Street, St. Louis 4, Mo.
Plants: St. Louis, Passaic, Los Angeles and Boston

Sales Offices
New York 7—50 Church St. • Chicago 3—79 West Monroe St.
Boston 27—426 First St. • Los Angeles 33—520 Anderson St.
Houston 2—1213 Capitol Ave. • Tulsa 3—224 Wright Bldg.
Cleveland 14—616 St. Clair Ave.
STOCKING DISTRIBUTORS IN PRINCIPAL CITIES

MIDWEST WELDING FITTINGS

MIDWEST WELDING FITTINGS Improve Piping Design and Reduce Costs

7055

RIGS AND PARTS*

IDECO
ONE OF THE DRESSER INDUSTRIES

RIG CAPACITIES
With 4½" Drill Pipe
A size and type for every depth — every job

16,000' to 20,000'	Model 1350-S, 1600-2400 HP input; torque converter drive.
15,000'	Model PR-1350, 1400 HP input; mechanical or fluid coupling drive.
14,000'	Model PR-1050, 1400 HP input; mechanical or fluid coupling drive.
12,000'	Model SUPER 7-11, 1200 HP input; torque converter, fluid coupling, or mechanical drive.
10,500'	Model 7-11, 1050 HP input; torque converter drive.
8,000'	Models H-750 and M-750, 750 HP input; torque converter, mechanical or fluid coupling drive.
7,000'	Model H-525, 525 HP input; torque converter drive.
6,000'	Model H-40, 400 HP input; torque converter drive; skid-mounted, or trailer-mounted as a Rambler Rig.
5,000'	Model H-35, 350 HP input; torque converter drive; skid-mounted, or trailer-mounted as a Rambler Rig.
4,500' and 3,300'	Models H-30 and H-25, 300 and 250 HP input; servicing depths 10,000' and 9,000'; torque converter drive; skid-mounted, or trailer-mounted as a Rambler Rig.
2,500'	Model H-20-B, 200 HP input; servicing depths to 7,500'; torque converter drive; skid-mounted, or trailer-mounted as a Rambler Rig.
3,000'	Model PR-150, 150 HP input; mechanical drive, air controls.

FOR DETAILED DESCRIPTIONS, SPECIFICATIONS, AND PERFORMANCE CHARACTERISTICS, GET YOUR COPY OF CATALOG NO. 54 FROM ANY J&L MAN.

Many a driller has promised himself that his next rig will be an IDECO. There are two reasons for this industry-wide trend.

First, every man has a natural desire to own the finest equipment money will buy, and these rigs are world-famous.

Second, J&L maintains IDECO parts stocks at centrally located points, ready for immediate delivery to any field in the United States and Canada.

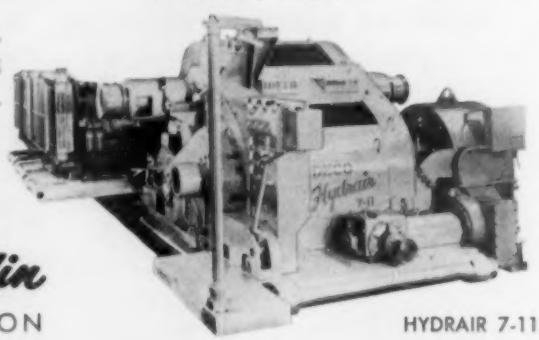
What is an IDECO HYDRAIR HOIST?

IDECO *Hydrair* hoists combine a *hydraulic* torque converter drive with *air* clutch and *air* controls

IDECO Power Rigs have a mechanical or fluid-coupling drive. However, like the Hydrair rig, there are air controls and air clutches. Mechanical drives are available with the PR-1350, PR-1050, SUPER 7-11, M-750 and PR-150.

* Where J&L stocks IDECO Parts

Casper, Wyoming
Great Bend, Kansas
Oklahoma City, Oklahoma
Shreveport, Louisiana
Corpus Christi, Texas
Wichita Falls, Texas
Houma, Louisiana
Hobbs, New Mexico
Edmonton, Canada

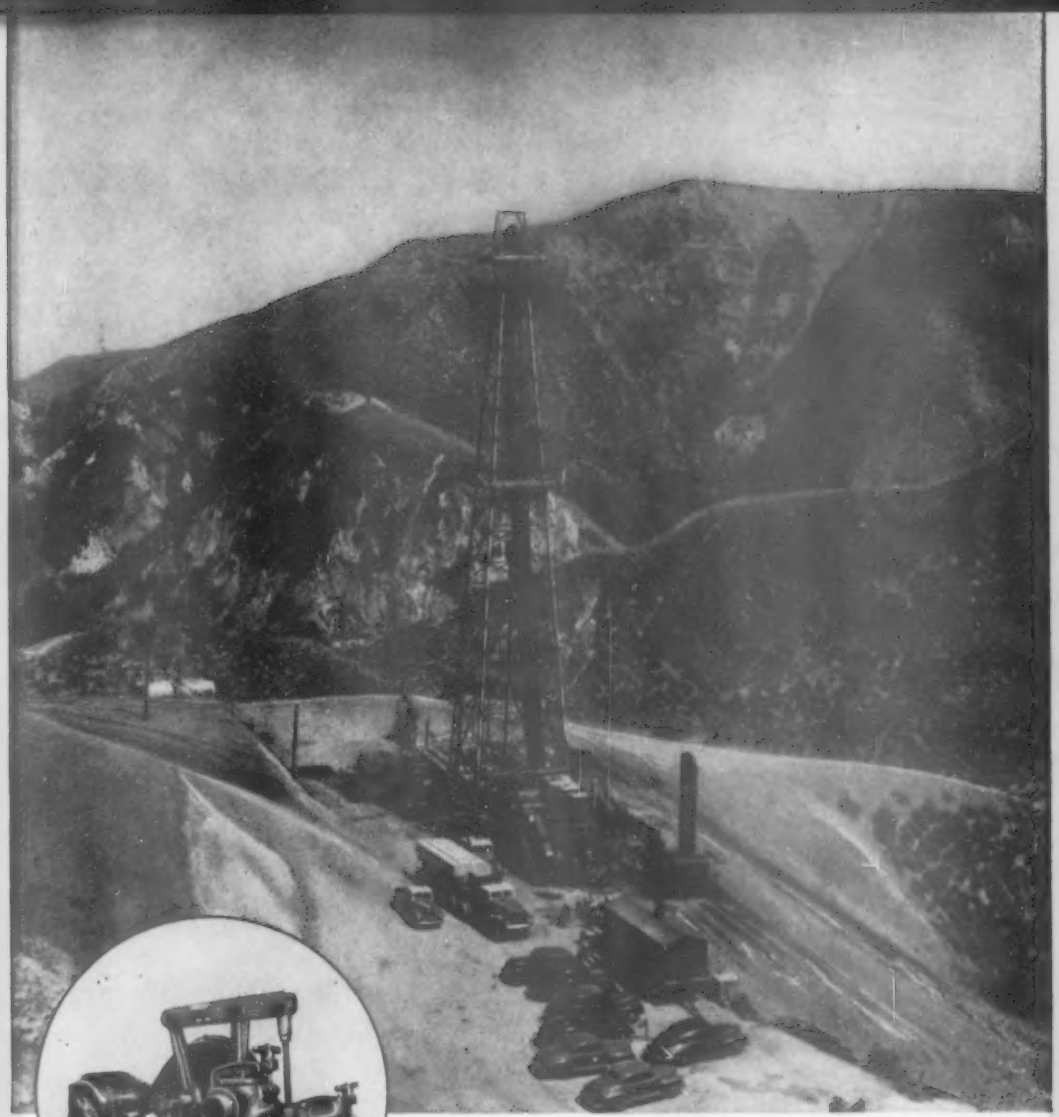


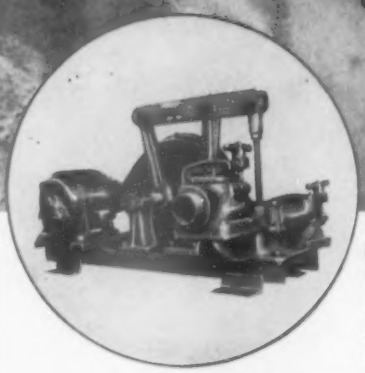
HYDRAIR 7-11

J&L STEEL

Jones & Laughlin
STEEL CORPORATION
SUPPLY DIVISION — TULSA, OKLAHOMA
Serving The United States and Canada

109-M





Rugged equipment for rugged country—no matter where the oil is, you'll find dependable Marlow Self-Priming Centrifugal Pumps around the drilling rig. Operators use these job-engineered pumps for rig washdown, brake cooling water, utility water supply and many other applications.

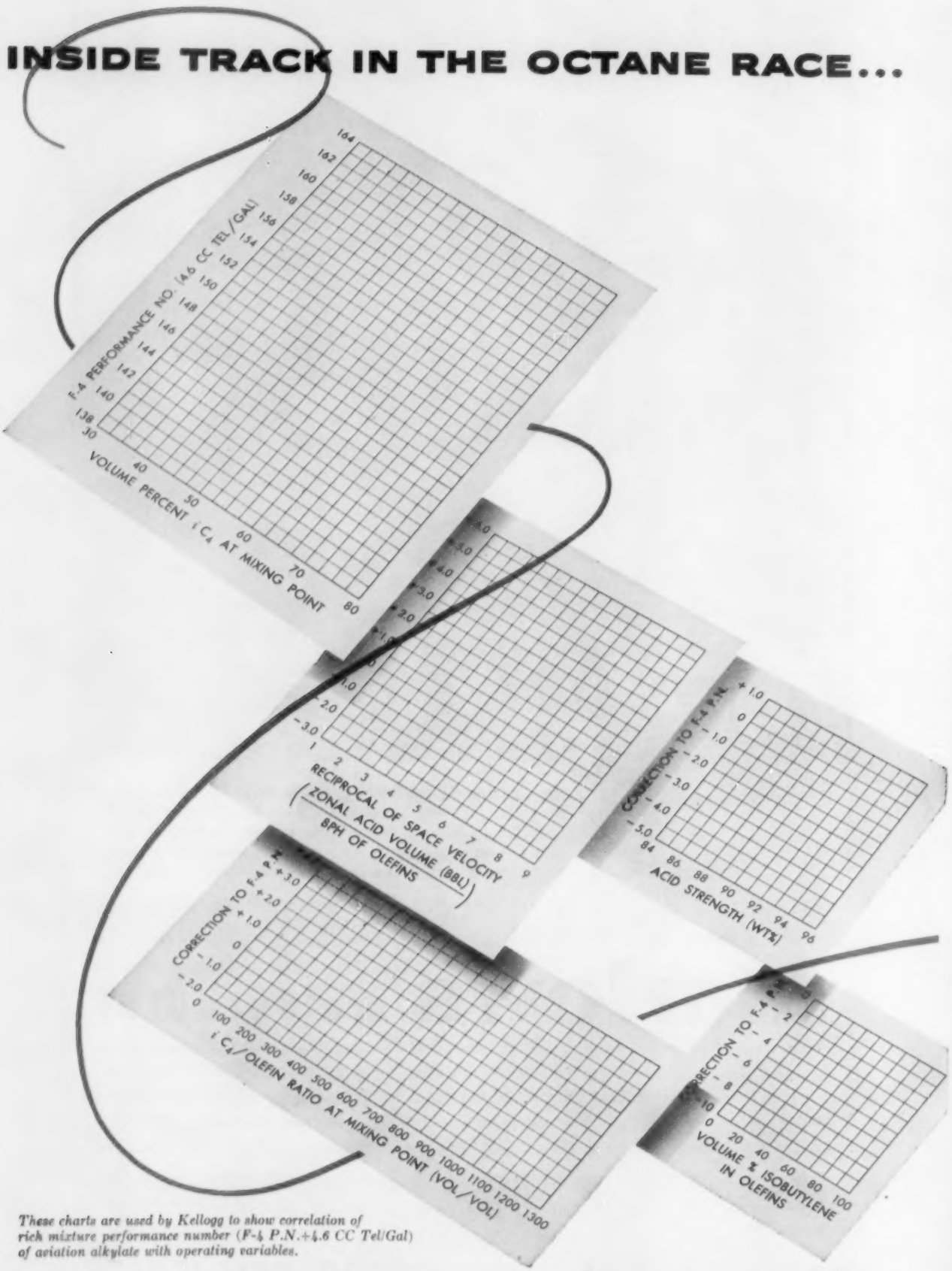
marlows are durable!

Built especially for oil country use, Marlow Self-Priming Pumps and Marlow "Mud Hogs" make a team that can't be beat. Marlows are "old hands" at oil country pumping. They've proved their durability for majors and independents alike on round-the-clock, trouble-free service. That's why more and more veteran oil men are making Marlows first choice. Make sure with Marlow . . . see your Marlow dealer or write for Bulletin O-53.

MARLOW PUMPS • RIDGEWOOD, NEW JERSEY

Division of BELL & GOSSETT COMPANY

INSIDE TRACK IN THE OCTANE RACE...


F-4 PERFORMANCE NO. +4.6 CC TEL/GAL
VOLUME PERCENT i C4 AT MIXING POINT
RECIPROCAL OF SPACE VELOCITY (ZONAL ACID VOLUME (BBL) / BPH OF OLEFINS)
CORRECTION TO F-4 P.N.
ACID STRENGTH (WT%)
i C4/OLEFIN RATIO AT MIXING POINT (VOL/VOL)
VOLUME % ISOBUTYLENE IN OLEFINS

These charts are used by Kellogg to show correlation of rich mixture performance number (F-4 P.N.+4.6 CC Tel/Gal) of aviation alkylate with operating variables.

Kellogg Alkylation

-INVESTMENT PAYOUT IN ONE YEAR!

A quick way to higher octane ratings at lowest operating and investment costs is sulfuric acid alkylation—utilizing Kellogg's unique cascade reactor and auto-refrigeration system.

Providing exceptionally high yields of superior alkylate, this Kellogg process sharply reduces the cost of the isobutane recycling equipment; maintains acid consumption at the lowest possible level; assures efficient mixing in reaction sections at low horsepower.

The accompanying co-ordinates demonstrate a few of the variables confronting the alkylate process engineer. The curves of these co-ordinates have been worked out through Kellogg research and experience, and the design results are available to refiners planning new alkylate capacity.

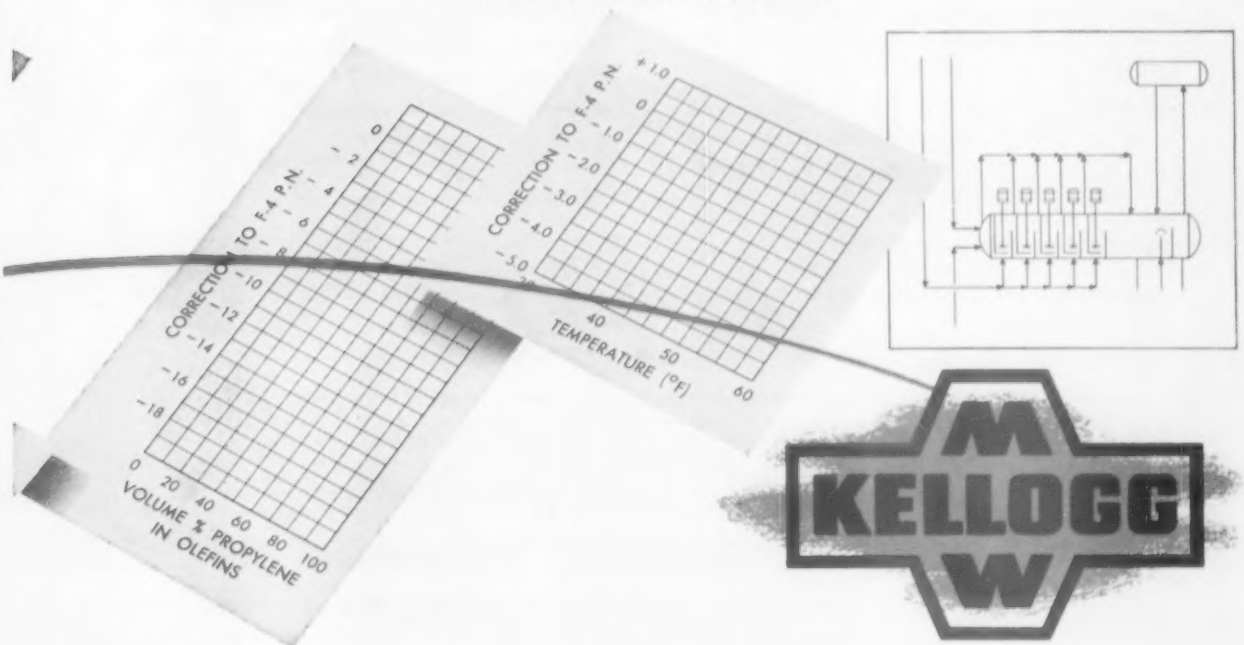
An example of what Kellogg alkylation can do in attaining premium results working with various blending components is provided by a recent study undertaken by Kellogg engineers of a proposed new 25,000 BPSD refinery on the Gulf Coast. Here, alkylation of total C_3 and C_4 olefins, assuming extraneous isobutane available at nominal price, results in the production of 15 volume percent on crude of high octane alkylate, with a payout on incremental investment over a base case of well under one year.

A comparable study of incremental alkylation not requiring extraneous isobutane, but compared with a base case incorporating non-selective catalytic polymerization, shows a payout of just over a year. Under these conditions alkylate production amounts to 6 volume percent on crude, and the combined alkylate plus catalytic polymer to slightly over 9 volume percent.

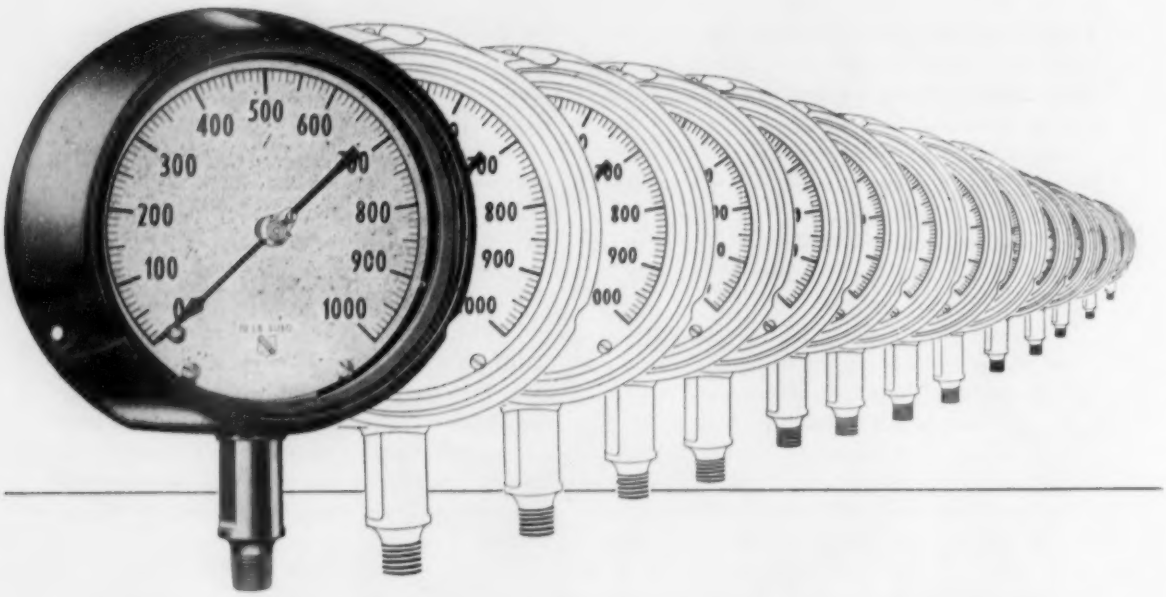
REFINERY PROCESS DIVISION, THE M. W. KELLOGG COMPANY, 225 BROADWAY, NEW YORK 7, N. Y.

In Canada: The Canadian Kellogg Company, Limited, Toronto. In Europe: Kellogg International Corporation, London

SUBSIDIARIES OF PULLMAN INCORPORATED



SATISFACTION MULTIPLIED
3x8x8x38x2x5



Service Conditions primarily determine the pressure gauge you specify for your installation. The wrong gauge can cost time, trouble, and money.

That's the big reason why Ashcroft Duragauges make sure of your complete satisfaction by offering a multiple choice in case designs and materials, Bourdon tube materials, ranges, movements, and dial sizes. Briefly, you can select the right gauge for your requirements from:

Cases of 3 different materials in 8 service-proved designs.

Bourdon Tubes of 8 different types of metals to meet specific service requirements.

Pressure Ranges from 30" vacuum or a few ounces through 100,000 psi.

Rotary Geared Movements that include the famous "Nylon Movement" or all stainless steel.

Dial Sizes from 4½" through 12".

Most important, Ashcroft Duragauges provide that unbeatable combination of highest sustained accuracy and durability of any pressure gauge built.

TAKE ADVANTAGE of the counsel of your nearby Industrial Supply Distributor. You can count on him to help you select Ashcroft Duragauges that will serve better and longer, with minimum maintenance, no matter how severe the conditions of vibration, pulsation, corrosion and weather.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

Above unretouched photograph shows the "guts" of the original 2" style 50 single ball race CHIKSAN Swivel Joint after 20 years of rigorous service in the California oil fields. Note the good condition of the wearing surfaces. This joint has been improved through the years to the present modern double ball race joint.

The CHIKSAN Ball Bearing Swivel Joint illustrated above is an unretouched photograph of a veteran of 20 years service on an oil well cementing hose.

CHIKSAN IS NO "JOHNNY COME LATELY" TO INDUSTRY...

Modern types of **CHIKSAN** *swivel joints.*

- Over a quarter of a century of "know-how" in design, manufacture, and successful application of swivel joints.
- Originator and largest exclusive manufacturer of ball-bearing swivel joints.
- The widest range of styles, sizes and pressures available for every major industry.
- Packing designs available for each specific service, assure constant torque at any given pressure.
- World-wide recognition for highest quality and lowest maintenance costs.
- Complete nation-wide coverage by qualified field service engineers.
- If you require unlimited flexibility with unlimited life—be sure you *specify* and *buy* CHIKSAN Ball Bearing Swivel Joints.

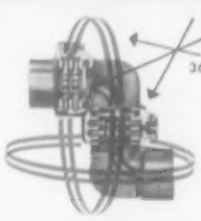
Supply and Service of CHIKSAN Ball Bearing Swivel Joints is always as near as your telephone. Write CHIKSAN for Specific Catalog Information. Dept. OGJ-4

The Flow of Enterprise Relies on

CHIKSAN

Ball-Bearing Swivel Joints

THE NEW TOOL OF MODERN INDUSTRY



CHIKSAN Ball Bearing Swivel Joints are THE NEW TOOL of Modern Industry with full 360° rotation in 1, 2, and 3 planes. Over 1,000 different types, styles, and sizes have been developed for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 70° to a plus 500° F. with packing materials for each specific service.

CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 3, Illinois • Newark 2, New Jersey

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Co., Brea, Calif., Newark 2, N.J. • Chiksan of Canada Ltd., Edmonton, Alta.

The NEW

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'L' SERIES PUMPING UNIT

Now in production, the LEGRAND "L" SERIES of pumping units contains a model to meet every need in mechanical pumping (from 4,000 lbs. to 25,000 lbs. polished rod load and 24" to 72" stroke) incorporating up-to-date design features derived from many years of practical field experience.

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- Floor-clearing Cranks.
- Rack-and-Pinion Balance Weight adjustment.
- A.P.I. Standard Gear Reducers.
- LEGRAND Patent Double-Taper Wristpins.
- Self-aligning Equalizer Wristpin Bearings.
- Lateral and fore-and-aft Beam adjustment.
- Swing-back Mulehead.
- LEGRAND Patent Carrier Bar.
- Central-point Lubrication.
- All bolting in "unified" series.

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HORSTED AIRPORT, ROCHESTER, KENT, ENGLAND

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"Yes, we know that area"

As a good many oil men will tell you, Murray Hill 8-1616 in Manhattan is the first thing they think of when financial problems crop up.

The Empire Trust Oil and Gas Department, 7 West 51st Street at Rockefeller Center, was created to serve the petroleum industry exclusively. Here you will find a versatile staff of financial consultants who have themselves many years of experience in and with your business.

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AVAILABLE JOHNSTON by AL CAPP

STOP!!
IT'S CROOL T' STUFF THAT CRITTER IN A HOLE!!
WE HEARS CATS' WHISKERS MEASURES OIL-WELL INSIDES!!-
Al Capp
NO!!-YOU HEARD THE JOHNSTON HYDRAULIC HOLE CALIPER IS THE CAT'S WHISKERS, FOR CHARTING BORE-HOLE DIAMETERS!!
IT LOGS SUB-SURFACE FORMATIONS, TO GIVE AN ACCURATE PROFILE-
SPEAKIN' O' PROFILES, YO' JOHNSTON BOYS GOT MIGHTY HAN'SOME ONES!!-
SORRY!!-WE GOTTA LOG A WELL, WIF THAT CALIPER THAT SAVES RIG-TIME!!

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JOHNSTON TESTERS

first in drill stem testing

HOUSTON, TEXAS

LOS ANGELES, CALIF. • CALGARY, CAN.

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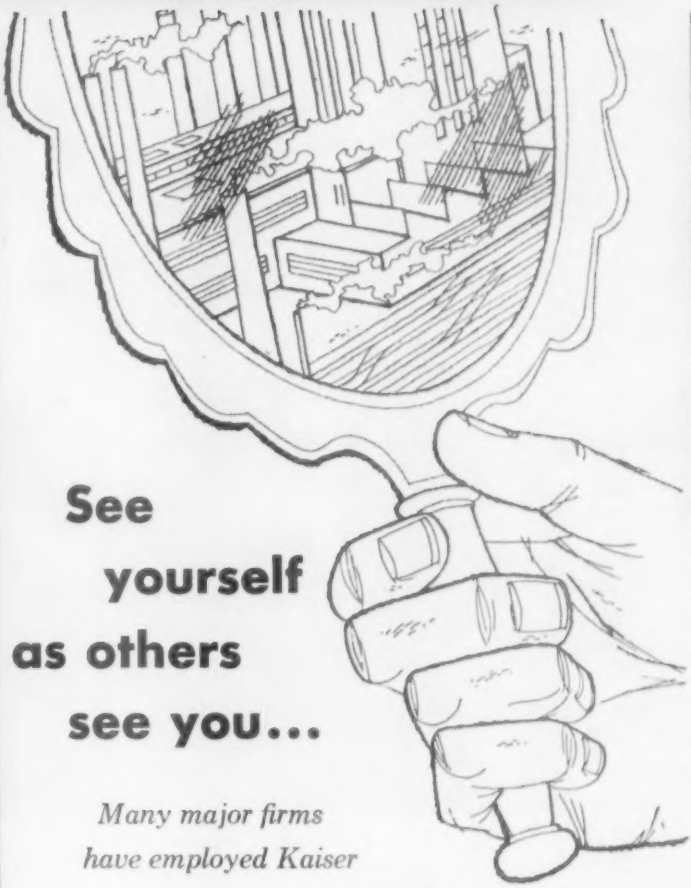
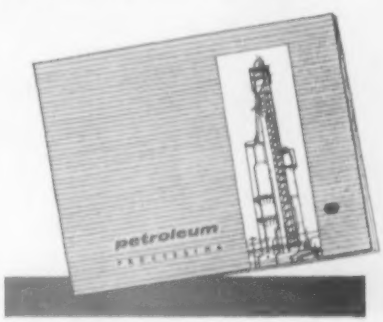
Capsule Case History:



Studies and Reports
for the petroleum and petrochemical industries are another feature service of the petroleum specialists within the Kaiser Engineers organization. For example, a comprehensive economic evaluation and profit analysis was recently completed for a major western refinery considering a cat-former addition.

This service is available to your firm in addition to or in conjunction with complete engineering studies for your next refinery project.

A new KE petroleum brochure is now available. Write for No. 103.



See yourself as others see you...

Many major firms have employed Kaiser Engineers to analyze their present problems and appraise future needs and prospects. Kaiser Engineers is particularly well qualified to provide this fact-finding service, for it has a wide diversity of talents to prepare engineering and economic feasibility reports, market and site location studies.

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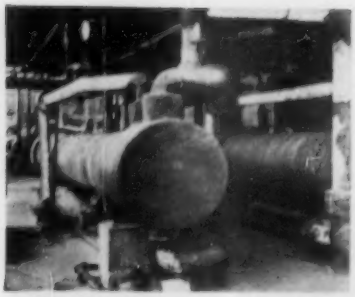
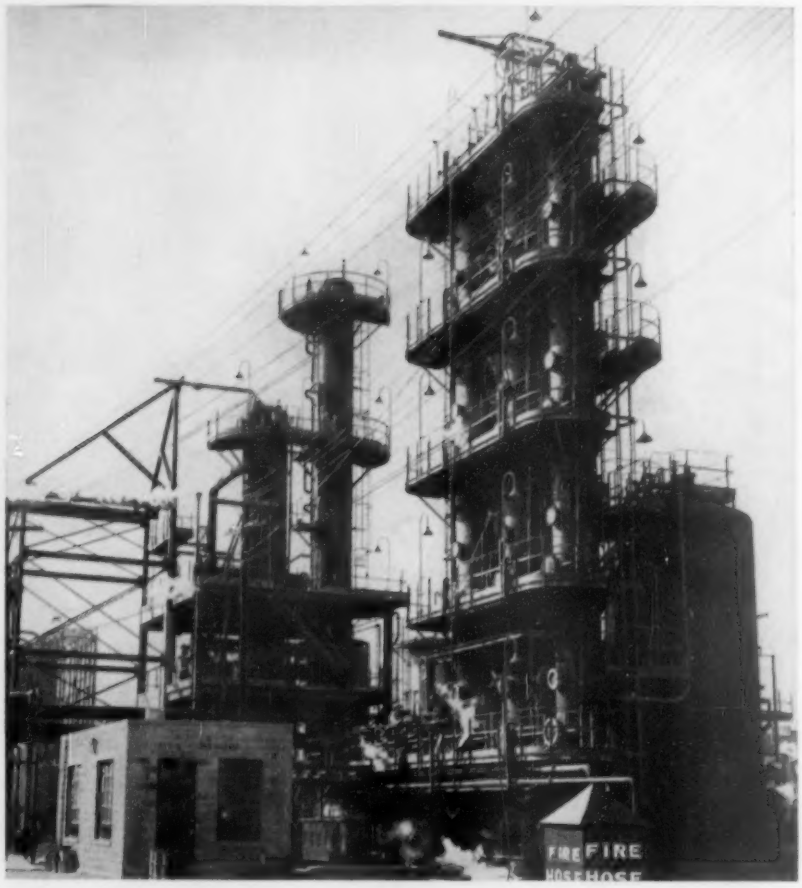
• HENRY J. KAISER CONSTRUCTION CO. • HENRY J. KAISER COMPANY (Canada) LTD., MONTREAL • KAISER ENGINEERS INTERNATIONAL, INC.



Heat Exchange between pure caustic leaving the Unisol process regenerating tower and contaminated caustic entering, is accomplished in this all-Monel preheater.

Mercaptans are Steam-Stripped from Methanol-Caustic Soda Solution in this Unisol process regenerator tower at Atlantic Refining Company's Philadelphia refinery. Monel construction protects the tower, piping, preheater and reboiler from the extreme corrosiveness of the hot caustic solution.



When it's a question of caustic corrosion . . . refiners find Monel effective

Wax is Washed Free of Caustic with hot water in these agitator tanks at Atlantic Refining. Coned bottoms and sides to a height of six ft. are lined with Monel to withstand caustic corrosion.

Wherever caustic soda is used in hot or concentrated solutions, it is apt to create corrosion problems. Two such places in the refinery are:

1. Caustic regeneration in mercaptan removal processes.
2. Lube oil and wax treatment.

In both processes, Monel is widely used for equipment that must stand up under corrosion by hot caustic solutions.

In caustic regeneration, you find Monel used for the regenerating towers, and for pumps, piping, preheaters and reboilers. For parts where temperatures may reach or exceed 500°F., as in evaporator tubes, Inconel is to be preferred for its superior resistance to sulfide-containing caustics.

In the large outdoor agitators where hot wax is allowed to settle, then washed free of excess caustic left after neutralization processes, Monel linings have proven to be a satisfactory solution to the corrosion problem. Both nickel and Monel equipment are used to store caustic solutions. "S" Monel, with its excellent anti-galling properties is combined with Monel in hard-to-lubricate pumps to prevent seizing.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

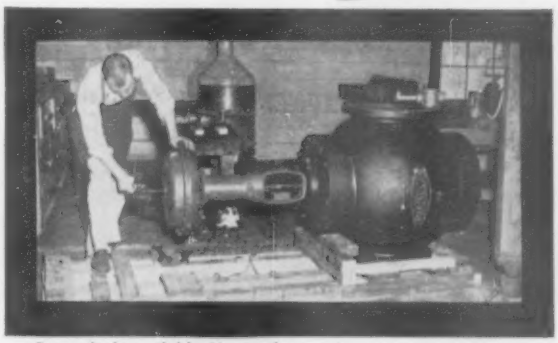
Have you a caustic soda corrosion (or purity) problem?
Then get in touch with Inco's Corrosion Engineering Section.
Write: International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

INCO Nickel Alloys

Monel . . for minimum maintenance

Rx for MASONEILAN Service

call PR-3135



Rugged, dependable Masoneilan equipment requires a minimum of service. However, when repairs or adjustments are necessary, MECO's completely equipped Houston shop offers prompt, dependable service for all types of Masoneilan controls.

MECO's carefully staffed and equipped Houston shop assures you that you will receive a full measure of the quality and dependability which is built into all Masoneilan equipment.

MECO

MAINTENANCE Engineering CORPORATION

P. O. BOX 2637

3711 CLINTON DRIVE
HOUSTON, TEXAS

HOW TO BUY ROTARY HOSE THAT LOWERS DRILLING COSTS

. . . gives you "More Use per Dollar"

Look for a rotary hose construction with engineered features that assure safe, easy handling . . . a strong, flexible hose with a streamlined coupling that protects you against costly leaks and blowouts on the job.

A hose that is strong, flexible and correctly balanced, without being bulky, holds steadier in the derrick — even under the high pressure of deep drilling. If the hose is also light in weight it is easier to make-up on the rig . . . easier and *safer* to transport from hole to hole without damage or accident. Insist on a hose with strength members properly engineered and positioned to assure maximum flexibility . . . to resist kinking that can cause internal weakness and eventual hose failures. Insist, also, on a hose coupling that is streamlined with no protruding lugs or collars to interfere with easy handling, a coupling specially engineered to guard against leaks and blowouts . . . to add to the long, trouble-free life of the hose and reduce rotary drilling costs.

Specify, by name, the rotary hose engineered to give you dependable service under all drilling conditions . . . specify "Ray-Man" CBL Rotary Hose.

RAY-MAN CBL ROTARY HOSE

Special high-tensile steel cable wire reinforcement, precision wound under tension, gives Ray-Man CBL Rotary Hose a degree of flexibility—and safety—never before equalled. With strong, flexible strength members, Ray-Man offers maximum resistance to accidental crushing. This flexibility adds to safety and long life . . . makes Ray-Man easier to transport and rig-up without accident. Manhattan's streamlined, built-in coupling features the blow-out proof "Lip-Lok" seal that tightens under pressure. It is designed without protruding lugs or flanges — nothing to cause fouling or damage. These features of Ray-Man CBL Rotary Hose add up to the highest safety factor, longest life and lowest cost per foot drilled for your drilling operations . . . "More Use per Dollar." Write for Bulletin #6743. RM 510

R/M

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings
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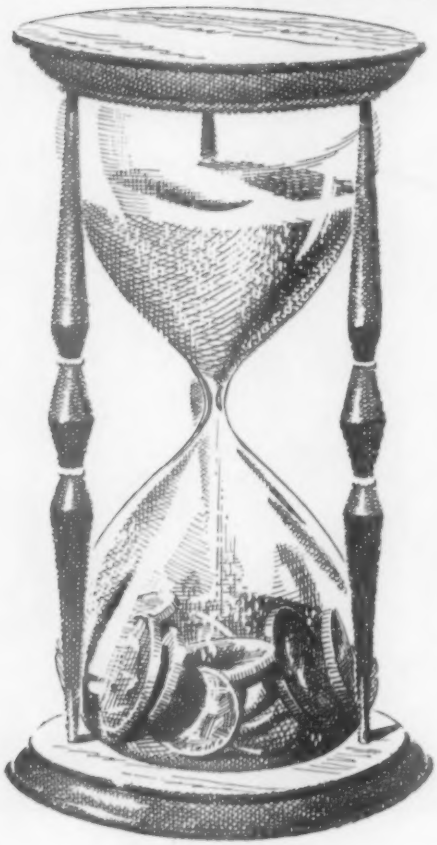
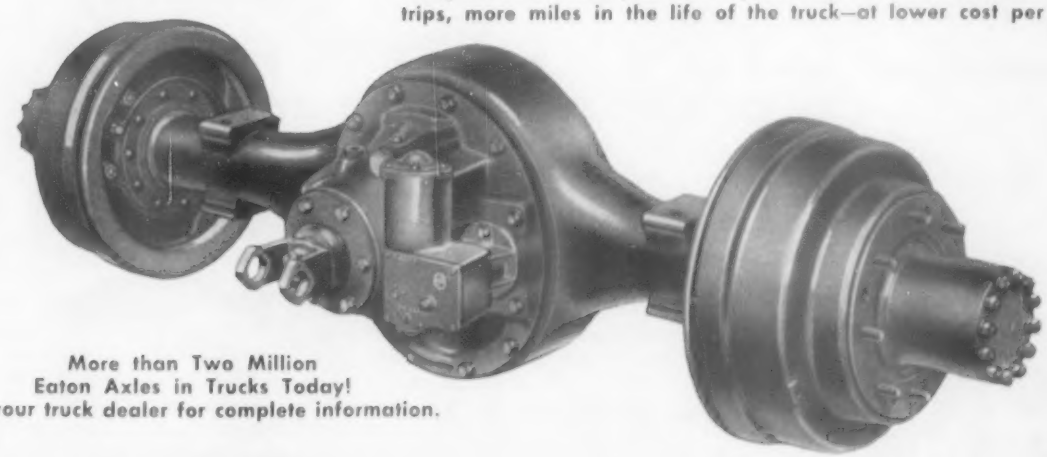
Eaton 2-speed Axles Turn Time into Money for Truck Operators



Eaton 2-Speed Axles may be the difference between profit and loss for those hauling jobs where time is a critical factor. They give trucks full pulling power for off-the-highway operation, plus the speed to make time on the open road. Because Eaton 2-Speeds reduce strain and wear on engines and power transmitting parts, and permit engines to run in their most efficient operating range, trucks are on the job—not in the shop. Eaton 2-Speeds give trucks greater maneuverability—an important factor in maintaining schedules in today's traffic. Eaton's exclusive features provide axles with greater stamina, hold maintenance to a minimum, assure maximum earning ability. Specifically: by supplying the right gear ratio for every road and load, Eaton 2-Speed Axles mean more and faster trips, more miles in the life of the truck—at lower cost per mile.



More than Two Million
Eaton Axles in Trucks Today!
Ask your truck dealer for complete information.

EATON AXLE DIVISION
MANUFACTURING COMPANY
CLEVELAND, OHIO

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

the site is ready for the rig

and a Loan from the ***FIRST*** *Cleared the Way*

put FIRST financing in your own oil future

1st

the Southwest's Pioneer Oil Bank

NATIONAL BANK in Dallas

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

Halfway round the world . . .

YET THE SERVICE IS THE SAME!

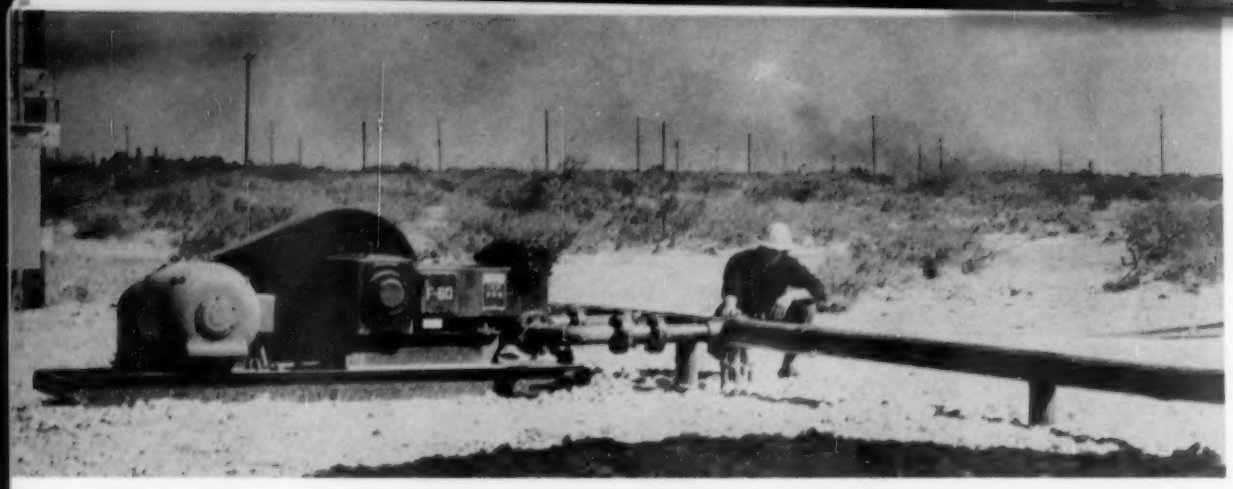
Imagine rigging up in a hot, humid jungle where two to five inches of rain can be a daily occurrence . . . where every item of equipment must come up river piece-meal! Where could you expect to get equipment service in such a remote spot, hundreds of miles from a city, nearly 7000 miles from the U.S.?

For a National Supply customer operating in New Guinea's jungles, the question never arose. Naturally, the National Supply man didn't drive up in the familiar blue car—it took him 7 days of island-hopping flying to get there. His visit, too, lasted a little longer than normal—twenty days.

But during that time, he performed the same services that National Supply men perform at rig sites in Texas, Wyoming, Canada, Venezuela or Australia. Besides assisting with the rigging up of the big 130 Ideal rig, he inspected and prepared equipment reports on another Ideal rig that was test drilling nearby.

The moral of this story is evident—whether you are six, sixty or six thousand miles away from a National Supply store or plant, the quality and trustworthiness of the supply service is always the same. There are 9500 people, 7 plants, 124 oil country stores and field representatives throughout the world working every day to keep it that way.

THE
NATIONAL SUPPLY
COMPANY



NOW... *continuous, trouble-free pumping of fluids*

under a wide range of pressure or volume conditions!

Bothered by repeated downtime on vital pumping jobs? National's Triplex Pumps are turning in round-the-clock, month after month service with little or no service downtime on a variety of pumping jobs.

National's simplified, rugged design and construction is the answer. Besides a heavy-duty pump case and frame, and long-life bearings, these pumps feature stainless steel valves and an exceptionally effective lubrication system.

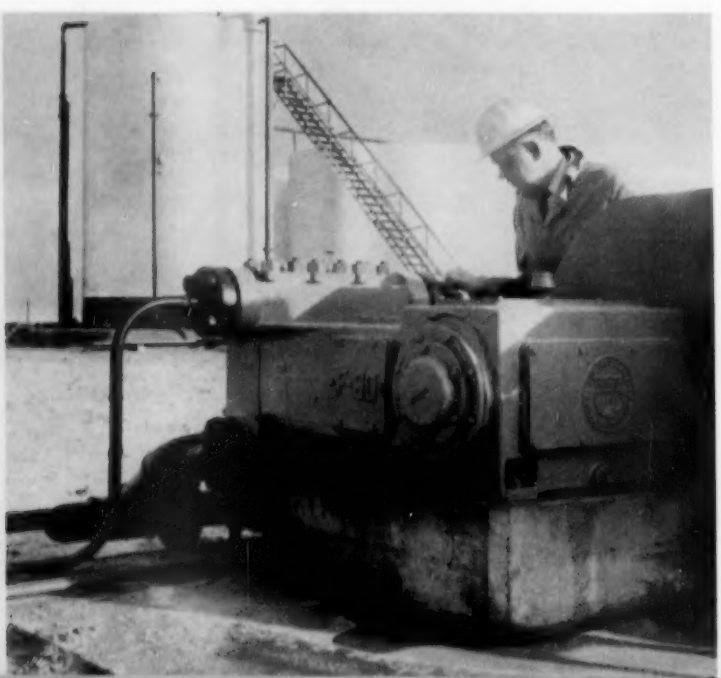
Corrosive fluids part of your problem? National Triplex Pumps are equipped with ceramic plungers when corrosive and abrasive conditions are part of operating specifications. For non-corrosive service, plungers are of exceptionally tough surface-hardened alloy steel for longest life.

Flexibility to meet pressure and volume requirements is provided by interchangeable plungers, fluid ends and stuffing boxes. (See chart at top of opposite page.)

Adaptable to either V-belt or direct drive, these pumps are easily fitted to unitized skid mounting for complete portability. And for minimum maintenance and new ease in plunger size changeover, National Triplex pumps feature easily removable cartridge type stuffing boxes.*

If you are after improved pumping performance, take a good look at the details and performance records of National Triplex Pumps. The National Supply field representative or store in your area has complete and up-to-date information for you.

*Patent Pending



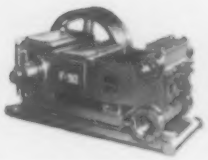
THE

NATIONAL SUPPLY

COMPANY

MAIN OFFICE: Two Gateway Center, Pittsburgh 22, Pennsylvania • DIVISION OFFICES: Denver; Ft. Worth; Houston; Toledo; Tulsa; Torrance • CANADA: The National Supply Company, Ltd., 200 F.W. Clark Building, 709 Eighth Avenue, West, Calgary, Alberta • EXPORT: 600 Fifth Avenue, New York 20, N.Y., U.S.A.; River Plate House, 12 South Place, London E.C.2

NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT • SPANG STEEL PIPE SUPERIOR AND ATLAS ENGINES

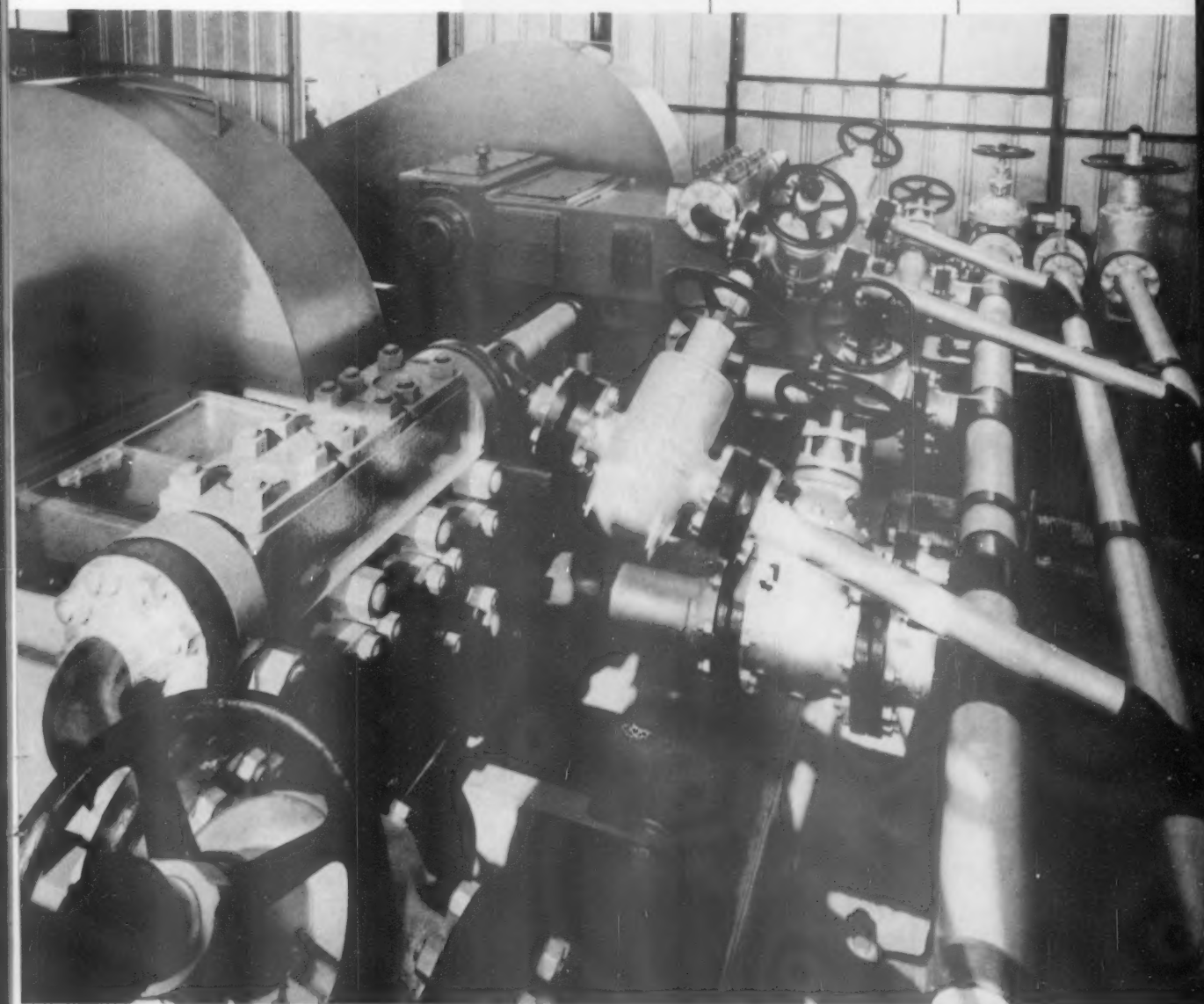


There's a **NATIONAL** *Triplex Pump for every job!*

National's Triplex Pumps provide improved performance for virtually every fluid pumping job. Used for waterflooding, and saltwater disposal, these pumps are equally efficient in high pressure testing, formation fracturing and acidizing, serving as a power-oil source for subsurface hydraulic pumping and a variety of refinery and petrochemical pumping jobs.

Model Number	Rated Discharge Pressure Range*	Barrels Per Day Range*
F-60-L (Low Pressure)	835 to 1575 psi	1120 to 4230
F-90-L (Low Pressure)	685 to 1345 psi	1955 to 7715
F-60-S (High Pressure)	1575 to 4975 psi	355 to 2240
F-90-S (High Pressure)	1660 to 5375 psi	480 to 3190

*Based upon standard pump speeds and rated HP output



See the next page for other improved

NATIONAL PRODUCTION EQUIPMENT

under any recovery method,
you'll gain new efficiency with

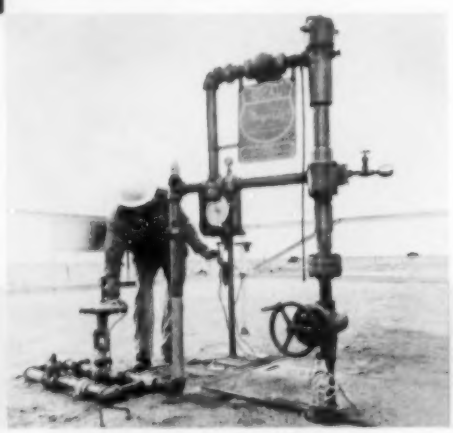
NATIONAL
PRODUCTION EQUIPMENT

NATIONAL *Sucker Rods*
are precision-manufactured in a range of grades engineered to suit virtually all well conditions, and readily available at the National Supply Store nearest you.

NATIONAL *Pumping Units*
are manufactured in 38 standard combinations, API rated beam loads from 3,200 to 32,400 lbs.—there's a model to economically suit every pumping job.

NATIONAL
Wellhead Equipment
has interchangeable units which provide a multitude of combinations to meet your specific needs in size, capacity and type. Ease of assembly and pre-tested safety are two major features of this equipment.

NATIONAL
Ideal Plunger Lift®
uses formation pressure for economically producing wells where reservoir conditions are suitable. For these certain types of wells, the Ideal Plunger Lift can be the best production method to use.



Be sure to have all the facts on National Production Equipment for either primary or secondary recovery operations. Complete technical information and product bulletins are available from the National Supply Representative or National Supply Store in your area.

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NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT • SPANG STEEL PIPE
SUPERIOR AND ATLAS ENGINES

You can now use emulsion muds in exploratory wells with no danger of affecting analysis of cores and cuttings

Those who visited our booth at the AAPG meeting (Los Angeles Biltmore, November 11 & 12), saw a demonstration under black light that proved some interesting facts about emulsion muds. An emulsion mud will speed up the rate of penetration by slicking up the hole, drastically lowering drill pipe torque, reducing wear and tear on equipment, depositing a thin mud cake, reducing filtrate loss, helping keep a hole "to gauge", and generally eliminating many sources of drilling troubles.

But geologists have repeatedly objected to the use of emulsion muds in exploratory wells (and rightfully so) because the oil in the mud contaminates cores and cuttings and makes it impossible to tell whether oil in the samples comes from the formation or from the emulsion mud. The only solution to the problem is to use a non-fluorescing oil for the emulsion mud. No-Glo is the only non-fluorescing oil commercially available today and our widely scattered field jobs to date have proved conclusively that No-Glo does not become colored or fluorescent under drilling conditions.

At the other extreme, core analysts have told us that there is no need to go to a non-fluorescing oil—that a diesel oil is adequate—because they can tell the difference in fluorescence and cut between a diesel oil and crude oil. In our demonstration under the black light such was not the case. Diesel looks very much like condensate, and after aging under temperature the unstable hydrocarbons in diesel oil polymerize and oxidize until the the diesel cannot reasonably be distinguished from crude oil.

Well logging crews themselves have conceded that under drilling conditions, diesel oil, stove oil, numerous other refined oils, fluorescing emulsifiers and crude oil all begin to look alike under the ultraviolet light and accurate interpretations are impossible.

No-Glo has improved drilling operations without interfering with geological interpretations, in many diversified domestic fields and in two foreign countries, and has been used with excellent results in an offshore job. For example, No-Glo was used successfully by Shell at Weeks Island, Louisiana (Gonsoulin-Minvielle State Unit #2) from 16,100' to 18,200'. This was the deepest producing well in the world when completed. Shell also used No-Glo in another well in this field for spotting opposite pipe that was tightly stuck at about 9,600' in a "keyseat". No-Glo not only freed the stuck pipe but prevented complications by introducing no fluorescence to the mud system. Others are now using it in wildcats in place of crude oil for freeing stuck pipe. A supply of 40 to 50 barrels at the rig ready for use, may save an expensive fishing job in case pipe becomes stuck. It is low-cost insurance.

No-Glo oil is a specially treated oil which may be added to any clay-water mud in the normal manner. A U. S. Patent has been allowed to Oil Base, Inc. on the use of No-Glo, and numerous foreign patents are pending. Licenses to oil companies and their subsidiaries to use No-Glo oil on a nominal royalty basis will be considered upon request.

If an emulsifier is to be used, White Magic is a whitish, readily-soluble, powdered emulsifier that does not fluoresce.

Together with No-Glo oil White Magic forms an excellent low-water-loss emulsion mud that has a flexible weight range, is electrically conductive, easily controlled and may be used without caustic soda for moderate pH ranges of drilling mud.

There are also many instances where pipe dopes gradually contaminate the mud and interfere with core and cutting interpretations. To prevent this hazard, insist on No-Glo Thread Lubricant when drilling wildcats even though an emulsion mud may not be required. No-Glo Thread Lubricant will not fluoresce and contains no fluorescence suppressors. Packed in 50 lb. pails.

Again, due to OBI research, a well-recognized need but hitherto unanswered problem has been solved. If you run into trouble during drilling and would like to switch to an emulsion mud that will not affect core analyses, No-Glo is the *only* answer.

OIL BASE, INC.

130 ORIS STREET, COMPTON, CALIFORNIA
Plants in Compton, Houston, Odessa, Duncan

BRANCHES: Bakersfield • Long Beach • Ventura
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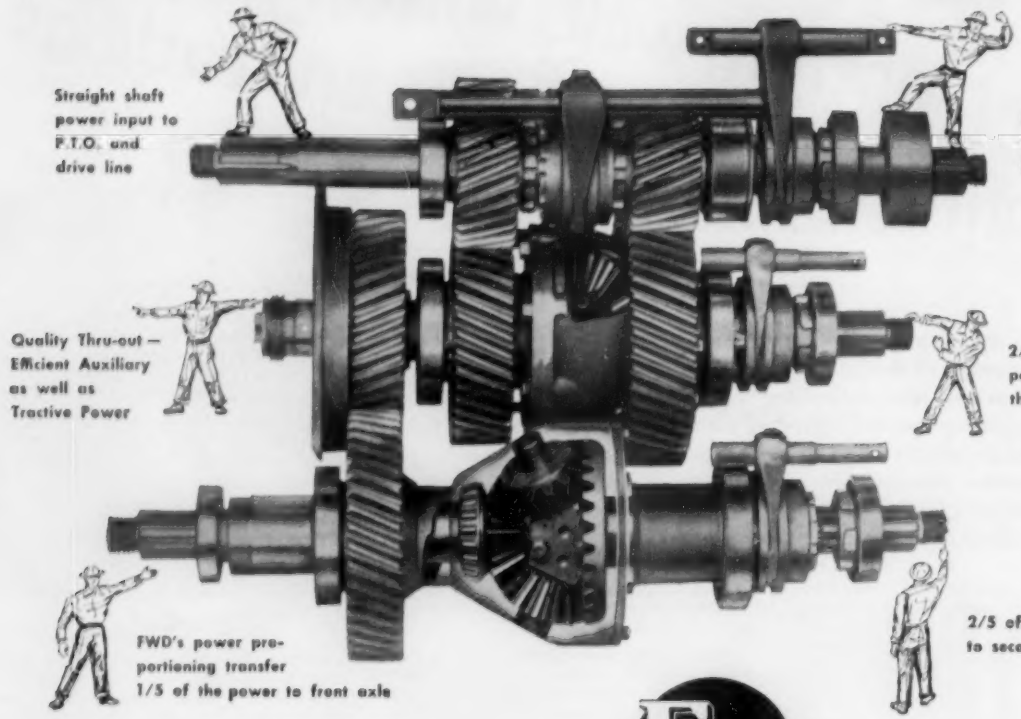
OB PRODUCTS

Power Proportioning Transfer- with The FULL TORQUE P. T. O. That EATS UP WORK...


Straight shaft power input to P.T.O. and drive line
Full torque, full ratio P.T.O. outlet
Quality Thru-out — Efficient Auxiliary as well as Tractive Power
2/5 of the power to third axle
FWD's power proportioning transfer 1/5 of the power to front axle
2/5 of the power to second axle

In the Oil Field. Auxiliary power comes as original equipment when you specify FWD Six Wheelers for your Oil Field Operation.

FWD's efficient, extended shaft, full torque P.T.O. is built in at the factory, to give you full engine torque at all transmission speeds for maximum power output. It is a quality built component, integrally designed as a part of the truck—not something to be added later as a conversion unit. Matched with FWD's dynamic power proportioning center differentials, which distribute power to each axle in proportion to load for maximum tractive effort, the result is a vehicle that is more than just a truck—a thoroughly engineered, efficient tool, designed for outstanding performance and dependability.

On your requirements for optional Auxiliary, as well as tractive power, see your FWD representative. He will be glad to show you how an FWD Six Wheeler can reduce your original equipment costs.

THE FOUR WHEEL DRIVE AUTO COMPANY

CLINTONVILLE, WIS. U. S. A.

REGIONAL SALES OFFICE
Phone 3461 Box 187 Duncan, Okla.

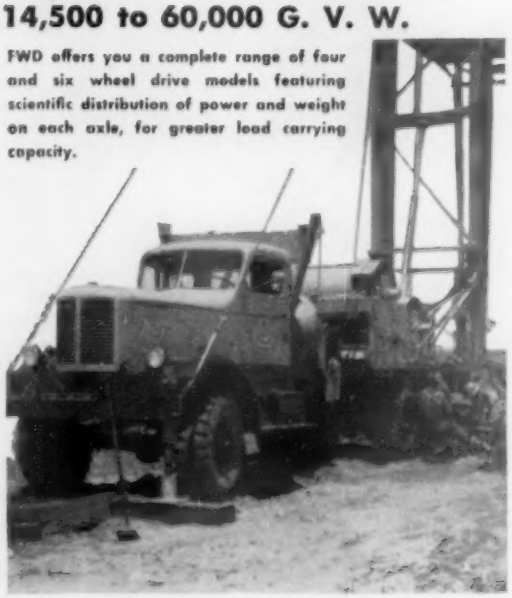
PARTS-SERVICE DEPOT
1215 Dragon St.
Phone: Prospect 6051
Dallas, Texas

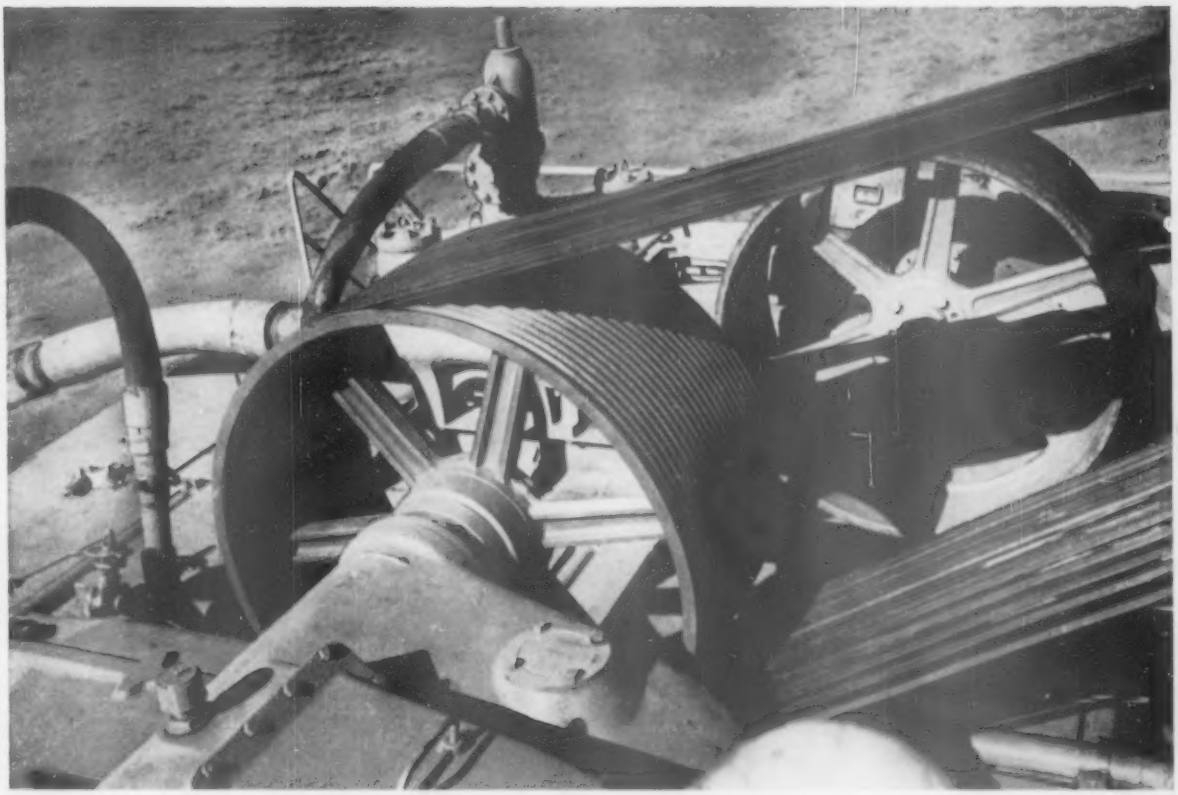
FWD®

FOUR & SIX WHEEL DRIVE TRUCKS

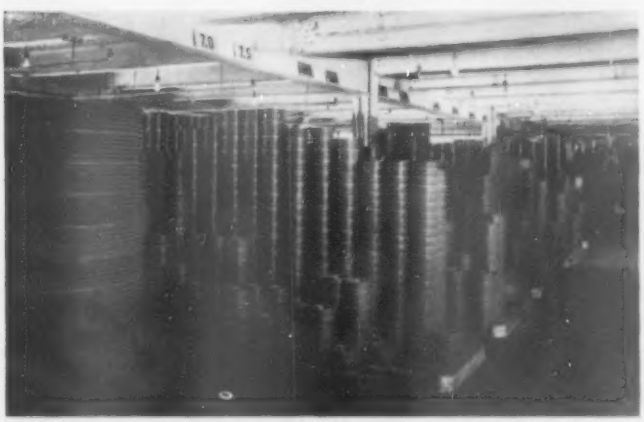
14,500 to 60,000 G. V. W.

FWD offers you a complete range of four and six wheel drive models featuring scientific distribution of power and weight on each axle, for greater load carrying capacity.





How much do sheave troubles cut your production time?



YOU DON'T HAVE TO WAIT for delivery of Worthington sheaves. Local distributors in all oil field areas are well stocked with most sizes. And they're backed up by factory stocks in Los Angeles, Fort Worth, Houston, Tulsa, New Orleans, Atlanta, Cleveland, Denver, San Francisco, Seattle, and Kearny, N. J.

Sheaves can be headaches.

If they're made with solid hub and bored for tight fit on the shaft, they're tough to get off. As a result, valuable production time is wasted during removal for shaft maintenance.

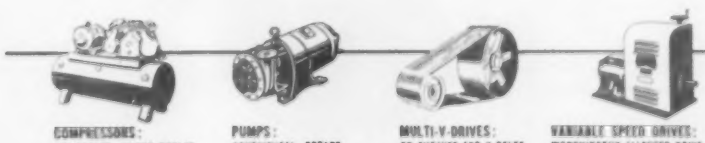
If they're built with solid hub and loose bore for quick, easy removal, they often don't hold the shaft tight enough to withstand heavy shock loads without slipping. Again you lose production time.

Not so with the Worthington QD! This sheave was especially designed to meet the demands of oil-production men. Its unique two-piece construction makes it easy to get on, easy to get off. But its heavy-duty, taper cone friction grip hugs the shaft tight, even against the heaviest shock loads.

It'll pay you to standardize on the Worthington QD*. Worthington Corporation, Oil City, Pennsylvania.

*Reg. U. S. Pat. Off.

MV.3.6



COMPRESSORS: AIR-COOLED, WATER-COOLED

PUMPS: CENTRIFUGAL, ROTARY, STEAM, POWER

MULTI-V-DRIVES: QD SHEAVES AND V-BELTS

VARIABLE SPEED DRIVES: WORTHINGTON ALLSPEED DRIVE

WORTHINGTON

Mechanical Power Transmission

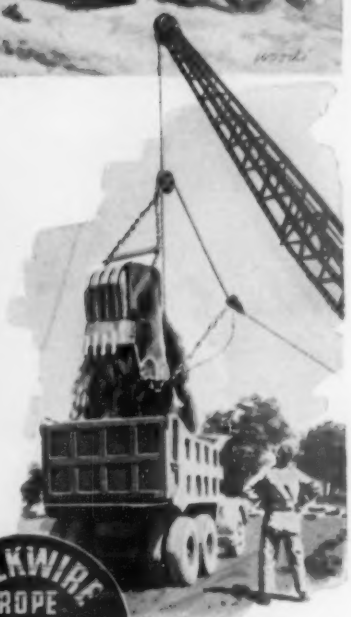
Buy these Worthington standard products from your local distributor

the dirt flies faster—now with MUSCLES OF STEEL

Straining laborers plying pick and shovel are a bygone memory because of today's excavating and road-building equipment. Modern power shovels and draglines use *muscles of steel*—rugged wire rope—to keep the dirt flying fast.

Helping to clear the way for needed highways is another of the important ways in which Wickwire Rope contributes *muscle* to America's might.

You'll find Wickwire Rope, too, in the mines and the quarries . . . in the oil fields and logging camps . . . with the fishing fleets . . . and in numerous materials handling operations. Whatever the job may be, the extra care and quality fabrication that goes into Wickwire Rope proves itself in longer life, more economical service and utmost reliability.



every industry benefits from wire rope

WICKWIRE ROPE

CF&I PRODUCT OF WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL AND IRON CORPORATION

2533

THE COLORADO FUEL AND IRON CORPORATION—Abilene (Tex.) • Denver • Houston • Odessa (Tex.) • Phoenix • Salt Lake City • Tulsa
PACIFIC COAST DIVISION—Los Angeles • Oakland • Portland • San Francisco • Seattle • Spokane
WICKWIRE SPENCER STEEL DIVISION—Boston • Buffalo • Chattanooga • Chicago • Detroit • Emlenton (Pa.) • New Orleans • New York • Philadelphia

Process Engineering: Standard Oil Development Co.; Construction Engineering: Brown and Root, Inc.

Creole Petroleum puts into service world's largest gas turbine installation

10 G-E UNITS DRIVE GAS COMPRESSORS FOR OIL-FIELD PRESSURE MAINTENANCE

The largest concentration of gas turbine horsepower in the world is now in continuous operation on a platform over Lake Maracaibo in Venezuela. There, seven miles from shore, ten General Electric gas turbines do a vital job for Creole Petroleum Corporation, driving centrifugal compressors which maintain gas pressure and thereby increase the yield from gigantic oil fields below.

CREOLE'S SUCCESSFUL INSTALLATION represents a new concept in oil-field pressure maintenance. The combination of centrifugal compressors and combustion gas turbines is designed to return 137,000,000 cubic feet of gas per day to the field at a pressure of 1935 pounds per square inch.

Naturally, reliability was an important reason for the selection of G-E gas turbines. Their light weight simplified the construction of the platform and its pilings.

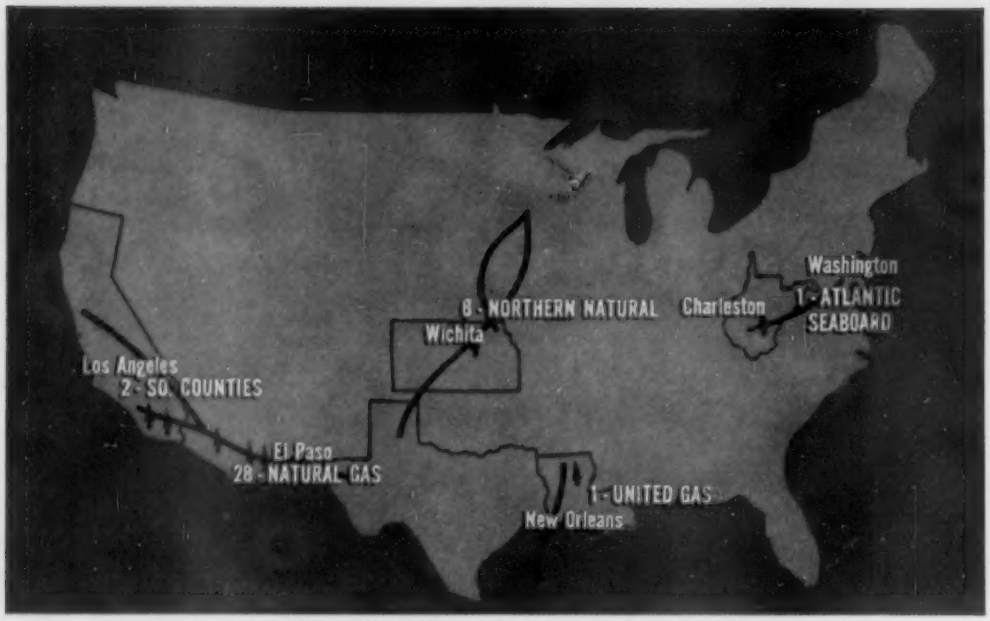
This remarkable installation is an outstanding example of petroleum industry enterprise and an important milestone in the progress of the gas turbine—industry's most important new prime mover.

This is another example of the versatility of the G-E gas turbine. Turn to the next page for a progress report on the use of G-E gas turbines in natural gas pipeline stations. To date, these gas turbines have logged more than 310,000 operating hours in this service.

SEE GAS TURBINES FOR GAS PIPELINES

Progress Is Our Most Important Product

GENERAL ELECTRIC



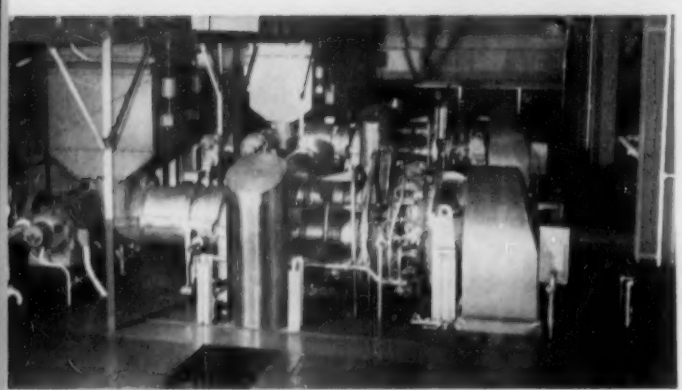
Installed throughout country . . .

40 G-E gas turbines

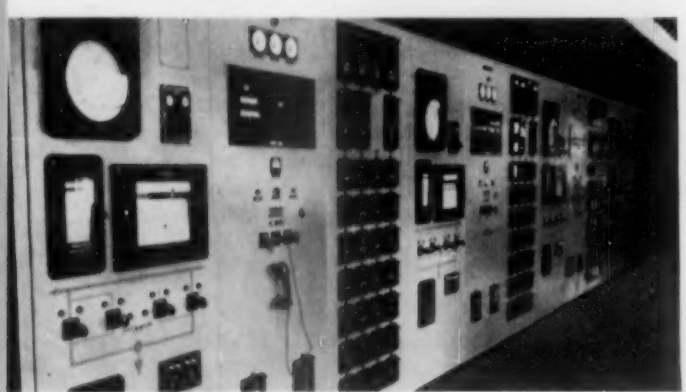
The 40 General Electric gas turbines in natural gas pipeline service throughout the United States have proved to be reliable, economical sources of power. Here are operating reports from installations on some of the country's outstanding natural gas pipelines:

EL PASO NATURAL GAS: The performance of 28 G-E gas turbines on this system has far exceeded expectations. They have operated for over 280,000 hours with a minimum of operating expense.

NORTHERN NATURAL: At this system's Tescott and Macksville, Kansas stations, eight G-E gas turbines are providing 25% more horsepower in the winter when gas demands are at a peak.

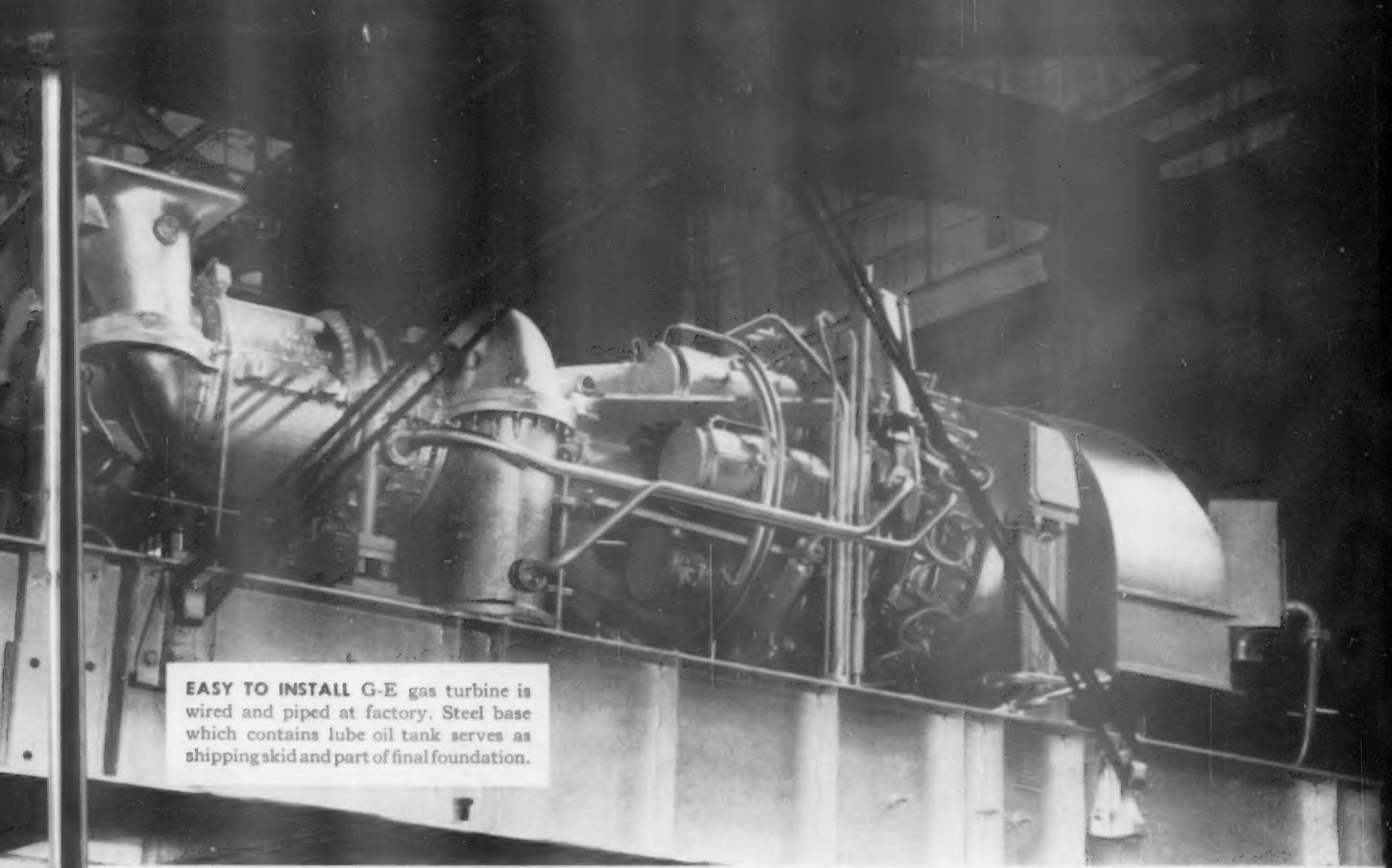


EL PASO Natural Gas reports 28 G-E gas turbines have helped to reduce system operating costs.



NORTHERN Natural Gas utilizes compact G-E control equipment for semi-automatic control of gas turbines.

ATLANTIC Seaboard has custom-engineered G-E Cabinetrol* unit for auxiliary control. *Reg. Trademark G-E Co.



EASY TO INSTALL G-E gas turbine is wired and piped at factory. Steel base which contains lube oil tank serves as shipping skid and part of final foundation.

provide reliable, economical service for gas pipelines

ATLANTIC SEABOARD: The flexibility of the G-E gas turbine is illustrated at this system's Seneca station as a 5000-hp unit helps Atlantic Seaboard successfully meet widely varying load demands.

SOUTHERN COUNTIES AND SOUTHERN CALIFORNIA GAS COMPANIES: This system with two G-E gas turbines, reports installations at Desert Center and Cactus City, Calif. have proved "very satisfactory."

UNITED GAS: In first use in initial mainline station, a G-E gas turbine at Napoleonville, La. helped United Gas reach an all-time system peak delivery of more than 4 billion cfd.

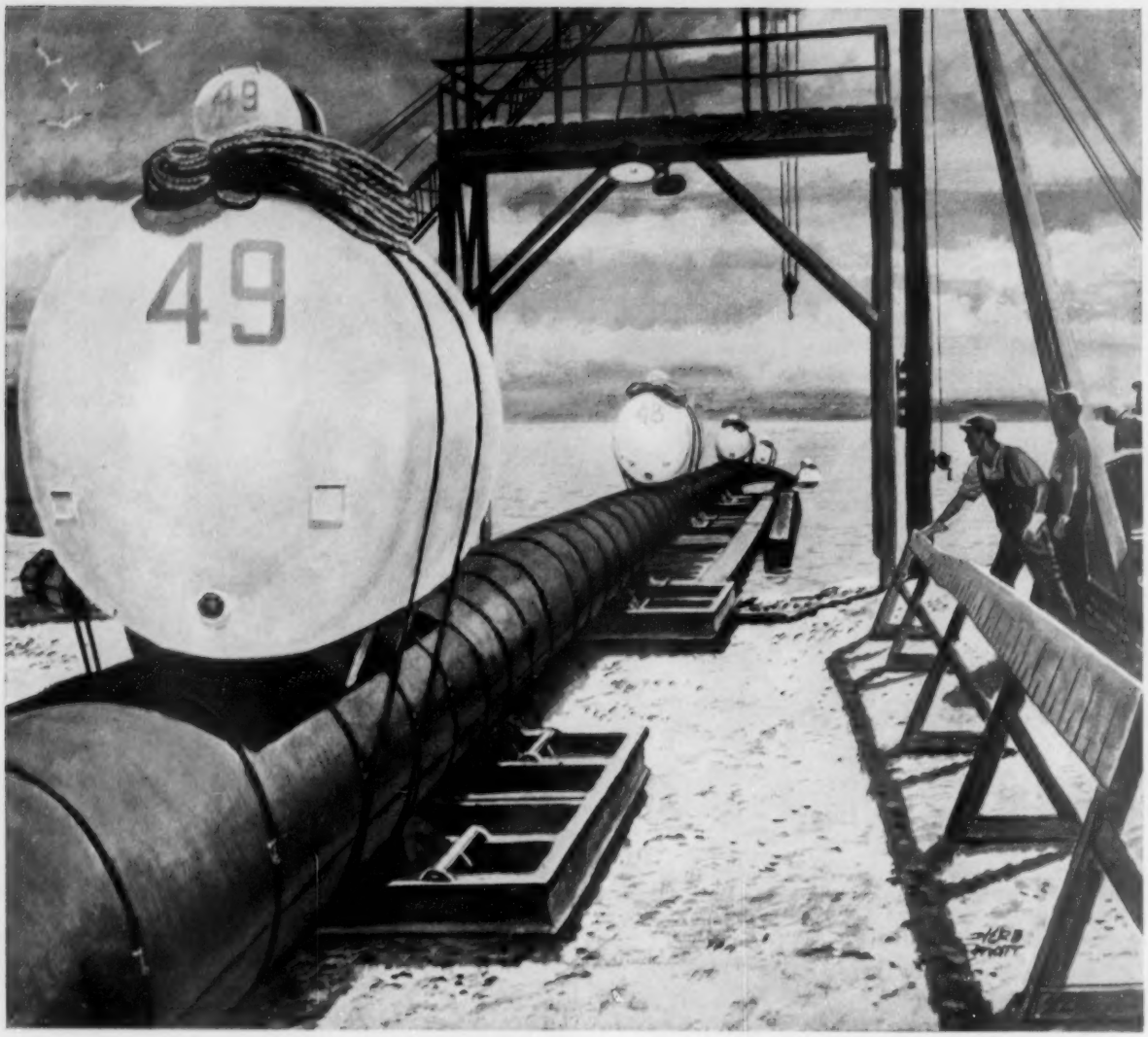
Follow the example of these 5 natural gas pipeline companies and install General Electric gas turbines on your pipeline system. For further information about G-E 6700-hp gas turbines, contact your nearest G-E Apparatus Sales Representative, or write for bulletin GEA-5962, Section 661-50, General Electric Company, Schenectady 5, N. Y.

Combustion Gas Turbines for the Gas Pipeline Industry—Backed by over 50 years of Turbine Leadership

GENERAL ELECTRIC

SOUTHERN Counties and Southern California Gas companies' regenerator increases efficiency.

UNITED Gas says G-E gas turbine installation at Napoleonville, La. has proved its reliability.



"Long haul" at Mackinac

Down she goes to the bottom of the famous Straits of Mackinac for the deepest underwater crossing ever made by a pipeline.

It was a tough job requiring the best in men and the best in materials. It is significant that Barrett Protective Coatings were specified from start to finish.

When you specify Barrett, you get not only the best in protective coatings, but the expert assistance of the Barrett Technical Service Group. Right at the planning stage, they'll help you select the coating that provides top protection at minimum cost. These coatings will prolong the life of steel pipelines indefinitely, while increasing the cost by only the smallest fraction.

In the field, Barrett Service Representatives are available for "on the job" assistance in the proper methods of handling and applying coating material.

We welcome the opportunity to place the Barrett Technical Service Group at *your* service. For detailed information—phone, write, wire Barrett.

Approved Barrett Applicators are available for field or special work throughout the country. BARRETT DIVISION, Allied Chemical & Dye Corporation, 40 Rector Street, New York 6, N. Y. In Canada: The Barrett Company, Ltd., 5551 St. Hubert St., Montreal, Que.

Allied Chemical

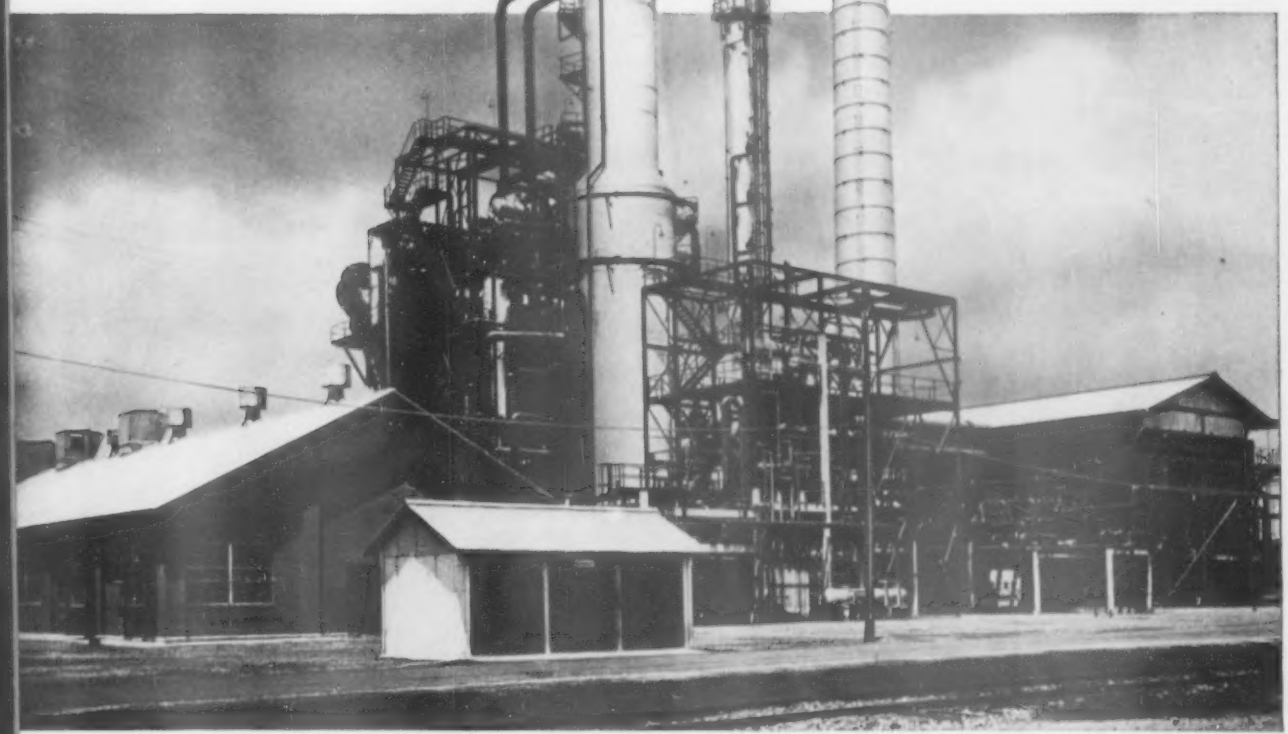
Barrett®

BARRETT PROTECTIVE COATINGS

OVER 100 YEARS OF EXPERIENCE

59 MILES OF Raymond PILES...

FOR TEXACO



THE TEXAS COMPANY is one of the many oil companies across the country that have selected Raymond for their foundation work. At their Eagle Point Works in Westville, New Jersey, over 59 miles of step-taper piles—10,028 piles in lengths up to 80 feet—were driven by Raymond to support a new Crude Unit and related structures.

Because of the wide geographical distribution of equipment and experienced personnel, you are assured of prompt and efficient service when you specify Raymond for your foundation projects.

RAYMOND'S DOMESTIC SERVICES
Soil Investigations . . . Foundation Construction
Harbor and Waterfront Improvements
Prestressed Concrete Construction . . . Cement-mortar Lining of Water, Oil and Gas Pipelines, In Place.

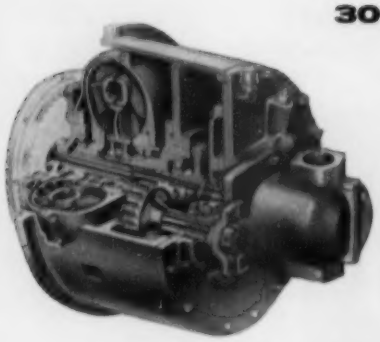
RAYMOND'S SERVICE ABROAD
In addition to the above, all types of General Construction.

Raymond
CONCRETE PILE CO.

140 CEDAR STREET • NEW YORK 6, N. Y.

BRANCH OFFICES
in Principal Cities of the United States, Canada, and Central and South America.

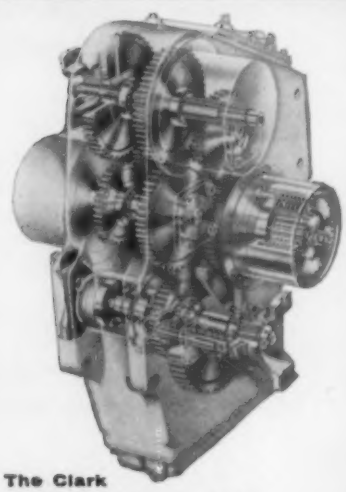
Faster... more power... better traction



The Clark Torque Converter

300% torque multiplication when you need it

1. You get 3-to-1 torque multiplication automatically when the going is toughest—smooth power, maximum traction.
2. You can't stall the engine—instead you get full power on the bucket cutting edge.
3. No clutch—eliminates the chief cause of operator fatigue and maintenance problems.



The Clark Power-Shift Transmission

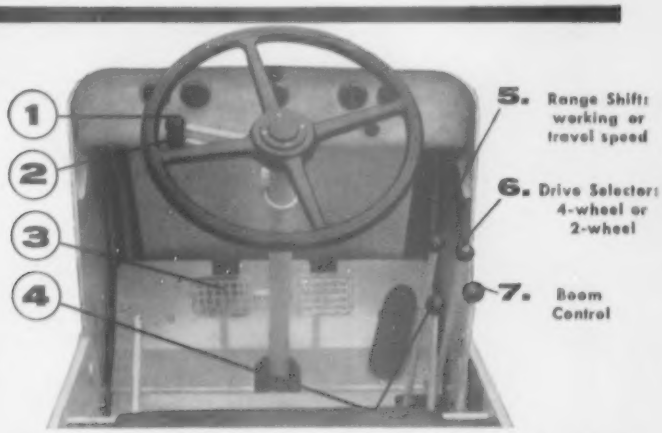
From engine to tires, the MICHIGAN power train has been engineered for superior tractor shovel service. For complete details and cutaway drawings, write for Tractor Shovel Broadside.

—and LOOK, NO CLUTCH !

Until you see a MICHIGAN® in action, you won't believe that a tractor shovel can deliver so much power and traction *with such ease of operation!* There's no clutch pedal on a MICHIGAN—it's as simple to drive as a brand-new car. And having eliminated the engine clutch, the MICHIGAN eliminates the most notorious cause of driver fatigue and excessive maintenance cost.

The MICHIGAN's remarkable ease of operation saves time in every cycle, adds up to more yardage per hour. The operator stays at peak efficiency because he doesn't have to fight a heavy-duty clutch all day.

To really recognize the superiority of this machine, all you have to do is see it in action. It's easily arranged, without obligation—write us for a demonstration. And MICHIGAN Tractor Shovels are available under a low cost Leasing Plan—glad to send you full details.



Hydraulic power does the shifting

1. Gears in constant mesh—no gear clash, noise or wear.
2. 4 speeds forward and reverse, up to 27 mph in both directions.
3. Oil re-circulated by pump lubricates entire transmission.
4. Power-shift levers on steering column actuate transmission control valves.
5. To put full power on the bucket, just step on the brake—you automatically put the transmission in neutral.

It's a pleasure to work here!

1. **Forward and Reverse:** easy hand-lever on steering column; make either shift while moving in either direction.
2. **High and Low Speeds:** another easy hand lever.
3. **That's no clutch!** It's a double-pedal brake, use it with either foot.
4. **Break-out bucket action:** work the bucket in the pile—you've got 2 double acting bucket cylinders for tremendous break-out power, independent low-level tip back action.

CLARK EQUIPMENT

CLARK EQUIPMENT COMPANY
Construction Machinery Division
448 Second St., Benton Harbor 28, Michigan
Phone: WA 6-6184

A MILE A DAY *installing* KRALASTIC* *pipe!*

12 miles of Kralastic pipe—probably the longest continuous plastic line in the country—was recently installed as a salt water disposal line at a speed of almost a mile a day!

Fabricated in lengths of 30 ft. and diameters from 2 to 6", the tough, rust-proof Kralastic pipe was installed by a crew of only 3 men—*all without previous plastic pipe experience!*

Distributed by two men—each easily carrying as many as ten lengths at once—the pipe was quickly and easily solvent welded by the third. Joined sections of several hundred feet were then simply thrown into the ditch.

No breakage occurred. There was no need for straightening of trenches or leveling of bottom—flexible Kralastic easily followed the uneven contours. Said the veteran pipe installation supervisor..."*have never seen one go in as easily as this plastic one. If I didn't actually see it done, I wouldn't believe it.*"

Want more? Kralastic pipe won't rot, rust, or corrode. A natural insulator, it never needs wrapping or electrolytic protection. It has outstanding impact, burst, and collapse strength—is unharmed by natural gas, petroleum, brine, and a wide variety of chemicals.

Better see what Kralastic can mean to *you*—in easier, faster, less costly installation—in far longer, trouble-free life. *Write to the address below today.*

Naugatuck Chemical

Division of United States Rubber Company

Naugatuck, Connecticut

US RUBBER

BRANCHES: Akron • Boston • Charlotte • Chicago • Los Angeles • Memphis • New York • Philadelphia
IN CANADA: Naugatuck Chemicals, Elmira, Ontario • Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N.Y.

WHY PRITCHARD SHOULD BUILD YOUR NEXT DESULPHURIZATION PLANT!

You want your next desulphurization plant to give you more production . . . more profit. The modern, compact, efficient design that Pritchard can develop for you assures you of more production and more profit.

Pritchard has proved its exceptional ability—earned and learned through long experience—to get this big job done right.

So, take your problem to Pritchard! Let Pritchard's skilled designers and engineers solve it as only they know how!

INDUSTRY'S PARTNER FOR PROGRESS

SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES

CHICAGO
HOUSTON
NEW YORK
PITTSBURGH
ST. LOUIS
TULSA

J.F. Pritchard & Co.
ENGINEERS • CONSTRUCTORS

Dept. 457 4625 Roanoke Parkway, Kansas City 17, Mo.

MR. INDEPENDENT knows the importance of follow-through on service since . . .

On A Rotary Rig, Every Minute Counts!

From the driller and tool pusher right on up, every oil man knows the importance of the race against time in drilling. Starting with the job design, through drilling practice, to completion of the hole . . . every element is figured to reach pay as quickly as possible to keep costs down.

This is one of the big reasons why oil men prefer to deal with independent distributors. They have enough problems on the rig during their daily tours, and enough headaches from meeting emergencies without having to worry about supplies. They know they can rely on their independent distributor to give them what they want, when and where they want it.

Here's why:

1. The independent knows the oil men he serves personally. He knows your problems and works along with you as a sort of friendly partner. Because of this, he is able to anticipate your requirements and have them on hand when needed.

For example, take the 19 independent distributors (listed at right), who handle Pittsburgh Seamless Oil Country Goods. If you need a string of drill pipe, casing or tubing, you can count on them to have it on hand when you need it and often on short notice.

2. When you buy from him, you know you are getting the best.

Your independent selects his lines of equipment from a broad range of producers, so he is free to choose those suited for your requirements.

3. His service is fast and flexible. Your distributor makes a specialty of serving a small area well, rather than spreading out his efforts over the country. He offers 24-hour service on even the smallest items of equipment. He is on hand to meet emergencies.

What is equally important, he is able to make decisions and give you the right answers quickly because he is not bound by inflexible rules or remote control in handling your requirements. Often the store manager of one of the 141 stores of the independents listed, can handle supply problems directly that otherwise would mean red tape and delay.

4. You can be sure his price is right. Your independent works on low overhead and long experience. He is used to competition, and depends for his livelihood on being able to meet it. That's why independents are handling nearly 60 per cent of the equipment business in the oil fields today, compared to 15 per cent back in the twenties.

5. There is nothing impersonal about your independent distributor. He's a close friend of yours who has lived close by your operations for many long years, and keeps in constant touch. Because you know him, and he knows you, you can do business with him conveniently and with less paperwork. And remember this: The profit he makes from his business stays in your area.

6. In meeting your requirements, the independent distributor is backed by reputable producers with long experience and know-how in the manufacture of the equipment you use. He handles Pittsburgh Seamless, for example, because he knows Pittsburgh Steel Company has been producing for more than 50 years and has established a reputation for doing a good job.

Newly modernized and expanded mills have equipped Pittsburgh Steel to do a better job for you today than ever before, offering the same close personal service that has become the trademark of the independent. The next time you order seamless, why not get the pipe of your choice through the supplier of your choice? Always specify Pittsburgh Seamless!

For Fast, Personal Service

—these independent distributors who carry Pittsburgh Seamless drill pipe, oil well tubing, and casing are ready to meet your requirements.

Home Offices

Bradford Supply Company
130 Main Street
Bradford, Pennsylvania

Buckeye Supply Company
18 Harrison Street
Zanesville, Ohio

C. W. Cotton Supply Company
Utica National Bank Building
Tulsa 5, Oklahoma

Franklin Supply Company
624 South Michigan Avenue
Chicago 5, Illinois

Houston Oil Field Material Co.
1524 Maury Street
Houston, Texas

Industrial Supply Company
500 Eighth Street
Wichita Falls, Texas

Iverson Supply Company
400 West Fifth Street
Tulsa, Oklahoma

Lucey Export Corporation
233 Broadway
New York 7, New York

Lucey Products Corporation
624 South Cheyenne
Tulsa 19, Oklahoma

McJunkin Corporation
P. O. Box 513
Charleston 22, West Virginia

Midland Supply Company
Box 3105
Washington St. Station
Wichita 7, Kansas

Mountain Iron & Supply Co.
100 Rule Building
Wichita 2, Kansas

Murray Brooks, Incorporated
P. O. Box 855
Lake Charles, Louisiana

Norvell Wilder Supply Company
P. O. Box 4145
Beaumont, Texas

The Producers Supply & Tool Co.
706 Commercial Standard Bldg.
Fort Worth 2, Texas

Rodman Supply Company
P. O. Box 2752
Odessa, Texas

Southwest Supply Company
1720 Oliver Building
Pittsburgh, Pennsylvania

Superior Iron Works & Supply Co.
P. O. Box 1800
Shreveport, Louisiana

Western Supply Company
424 North Boulder Avenue
Tulsa 1, Oklahoma

Pittsburgh Seamless Oil Country Goods . . . *a product of*

Pittsburgh Steel Company

Grant Building • Pittsburgh 30, Pennsylvania

DISTRICT SALES OFFICES: Atlanta • Chicago • Cleveland • Columbus • Dallas • Dayton • Detroit Houston • Los Angeles • New York • Philadelphia • Pittsburgh • San Francisco • Tulsa • Warren, Ohio.

PLANTS: Monessen, Pa. • Allenport, Pa. • Akron • Los Angeles • Unionville, Conn. • Warren, Ohio • Worcester, Mass.

PRINCIPAL PRODUCTS: Hot and Cold Rolled Strip and Sheets • Strip Specialties • Seamless Tubular Products • Wire and Wire Products • Chain-Link Fence • Cargotainers • Steeltex

ROEBLING ANNOUNCES ITS NEW

Royal 1105 Blue

WIRE ROPE . . . 15% STRONGER THAN YESTERDAY'S GUARANTEED STRONGEST!

15% MORE STRENGTH is a whopping improvement. But translate that extra strength into terms of increased service life and you've really got something to brag about.

★ What's more, Roebling is pulling no punches on the variety of this new rope that will soon be available. You'll be able to get **ROYAL BLUE** Wire Rope in EVERY DIAMETER from ¼" to 3½" . . . in EVERY STANDARD CONSTRUCTION with an independent wire rope core.

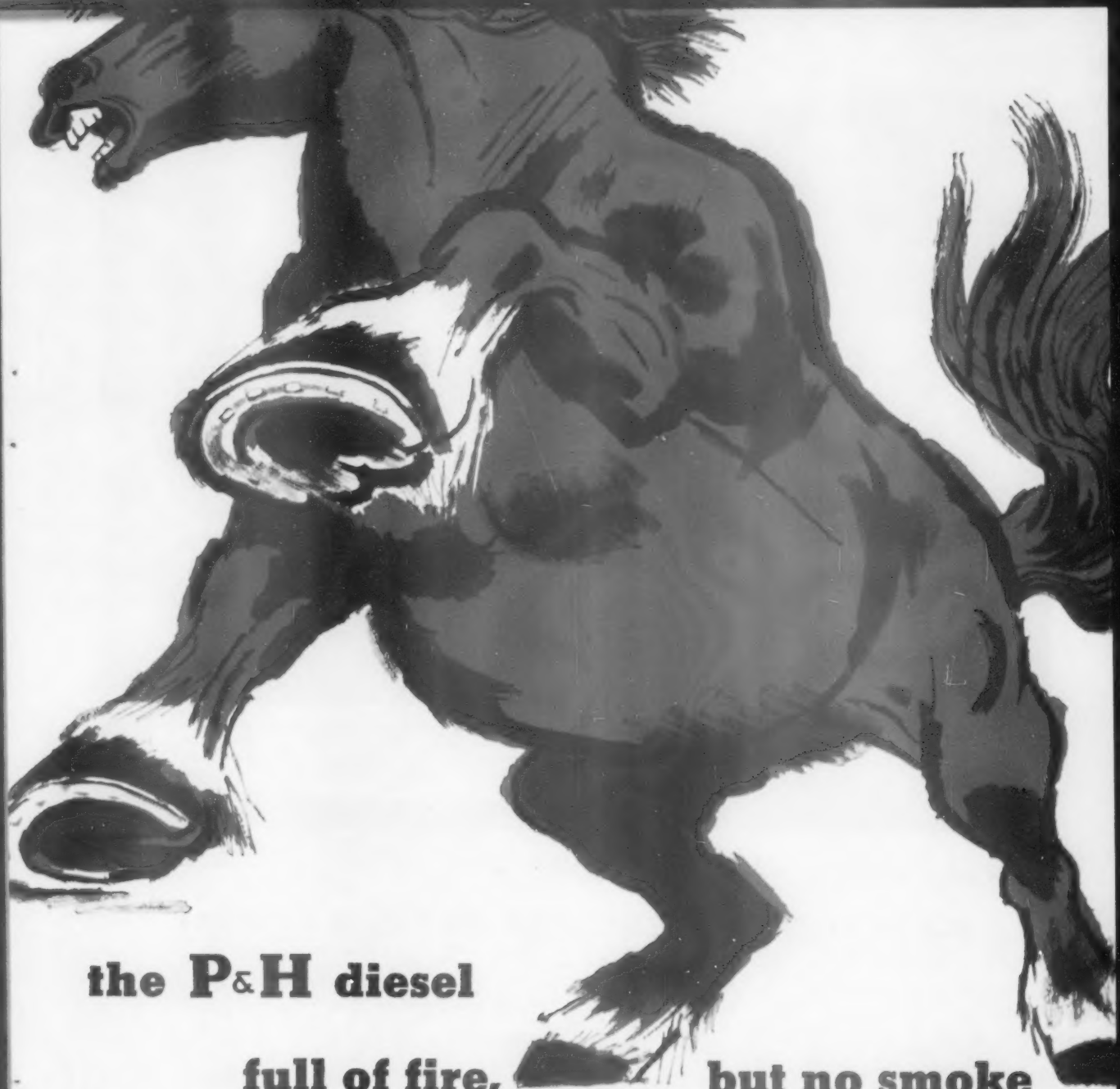
★ In addition to new high strength, Roebling type 1105 wire – the finest high carbon rope wire ever produced – gives **ROYAL BLUE** Wire Rope amazing toughness and resistance to impact, crushing, abrasion and fatigue.

★ As the first step toward completely new service economy, write us for the whole story on **ROYAL BLUE** Wire Rope, or contact your distributor or nearest Roebling branch office.

ROEBLING

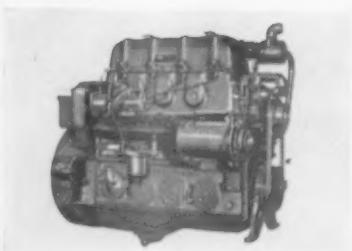
Subsidiary of The Colorado Fuel and Iron Corporation

JOHN A. ROEBLING'S SONS CORPORATION, TRENTON 2, N. J. BRANCHES: ATLANTA, 934 AVON AVE. • BOSTON, 51 SLEEPER ST. • CHICAGO, 5525 W. ROOSEVELT RD. • CINCINNATI, 3253 FREDONIA AVE. • CLEVELAND, 13225 LAKEWOOD HEIGHTS BLVD. • DENVER, 4801 JACKSON ST. • DETROIT, 915 FISHER BLDG. • HOUSTON, 6216 NAVIGATION BLVD. • LOS ANGELES, 5240 E. HARBOR ST. • NEW YORK, 19 RECTOR ST. • ODESSA, TEXAS, 1920 E. 2ND ST. • PHILADELPHIA, 230 VINE ST. • SAN FRANCISCO, 1740 17TH ST. • SEATTLE, 900 1ST AVE. S. • TULSA, 321 N. CHEYENNE ST. • EXPORT SALES OFFICE, TRENTON 2, N. J.



the P&H diesel

full of fire, but no smoke



Series C-18 P&H Diesels — now with *single*, fully self-contained fuel pump; perfect timing and balance for each cylinder. 30 to 255 horsepower, two-cycle. 2, 3, 4, 6-cylinder models, speeds up to 1800 r.p.m. Stationary, mobile, marine, diesel-generating sets.

The better the combustion, the less the smoke — and the P&H is a *clean* diesel.

But check its efficiency in other ways. Cost per horsepower . . . it's the lowest of them all. *Weight* per horsepower . . . again the lowest. *Honest* horsepower . . . it's measured at the driveshaft where it all works for you.

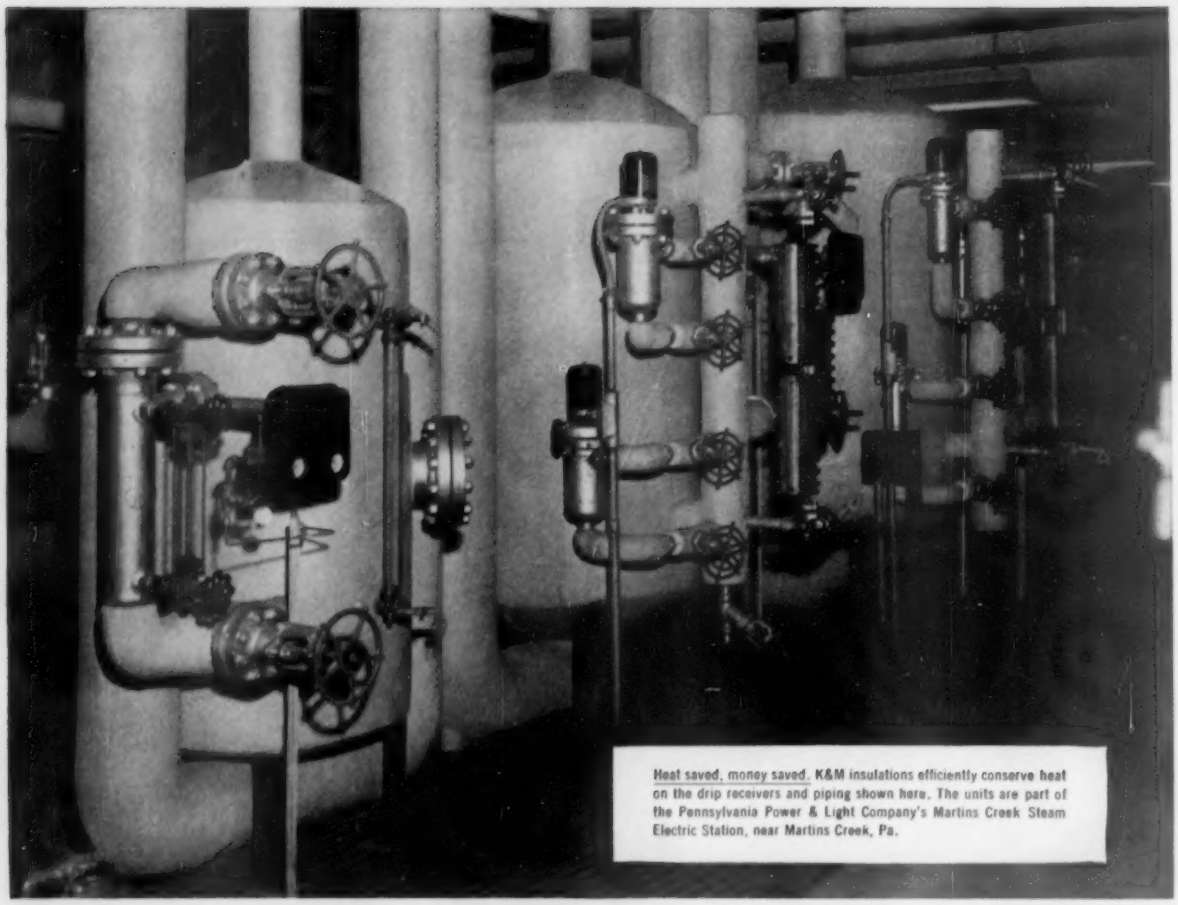
Service? A P&H Diesel takes little of that. When it does, *how easy*. You can replace a whole cylinder assembly as a unit — in hours instead of days!

Quite an engine, this P&H Diesel . . . we'll be glad to send you the whole story. Write: P&H Diesel Engine Division, Harnischfeger Corporation, Crystal Lake, Ill.

HARNISCHFEGER

the P&H Line

TRUCK CRANES · DIESEL ENGINES · POWER SHOVELS · PREFABRICATED HOMES · HOISTS · SOIL STABILIZERS · WELDING EQUIPMENT · OVERHEAD CRANES



Heat saved, money saved. K&M insulations efficiently conserve heat on the drip receivers and piping shown here. The units are part of the Pennsylvania Power & Light Company's Martins Creek Steam Electric Station, near Martins Creek, Pa.

Keep Heat Losses Down with

K&M HIGH PRESSURE INSULATIONS!

Efficient heat conservation means *real* dollar savings. Get those savings by using K&M high pressure insulations—known for years for their exceptional efficiency in minimizing heat losses.

K&M "Featherweight"® 85% Magnesia and K&M Hy-Temp Insulation last the life of the equipment they serve. They withstand moisture, vibration, and frequent temperature changes. Both are supplied in various sizes and thicknesses. When used together, these materials—with staggered joints—eliminate the heat loss that normally occurs in single layer installations when expansion causes joints to open.

Efficiency to 1900° F. K&M Hy-Temp Insulation is used on applications where temperatures rise to 1900° F. It's made of diatomaceous silica combined with heat-resistant mineral fillers and asbestos fiber. Usually, it's applied in combination with K&M "Featherweight" 85% Magnesia.

Efficiency to 600°F. K&M "Featherweight" 85% Magnesia is used for effective insulation of piping and equipment with temperatures up to 600° F. 85% of this material is composed of basic carbonate of magnesia, the remainder of asbestos fiber.

Efficiency to 450°F. K&M "Featherweight" Water-Resistant Magnesia Insulation is used on equipment with temperatures up to 450° F. It is especially effective where severe water exposure may damage insulation, or where high humidity and moisture are present.

Act today. Don't let continued heat losses keep operating expenses piling up. Contact your K&M distributor for information on these insulations, or write directly to us.

KEASBEY & MATTISON
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K&M best in asbestos®

ENGINEERING REPORTS:

G-E electrical systems for refineries are...

EASY TO EXPAND

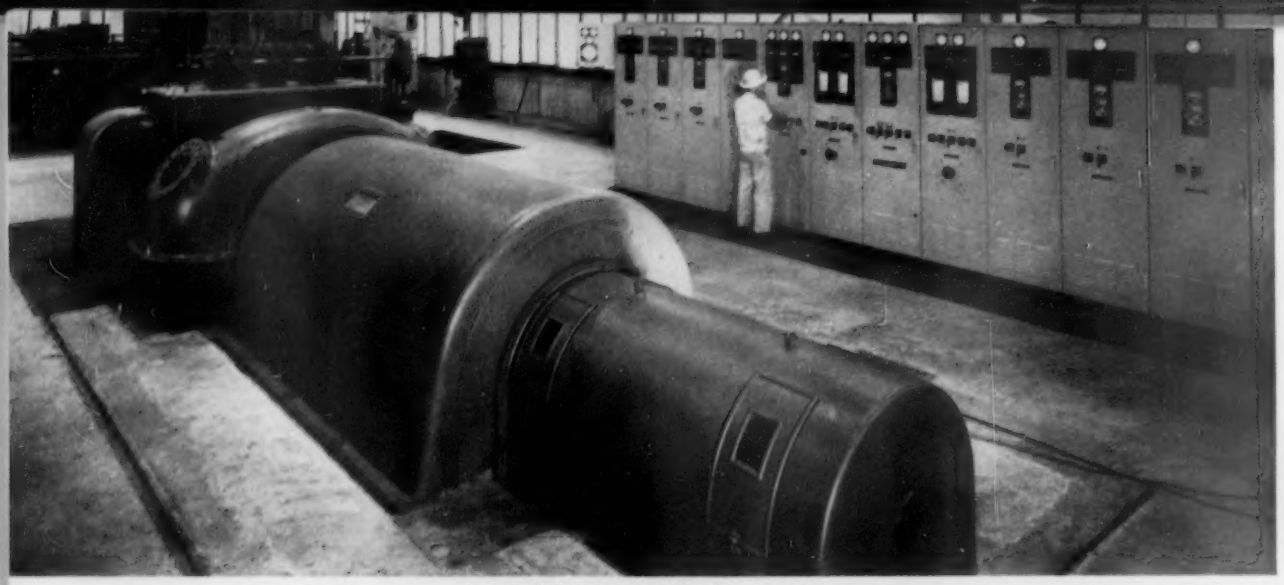
Easy to expand General Electric electrical systems will help make modernization or expansion programs in petroleum refineries more economical. Here's why:

- **Flexible G-E system design simplifies the addition of new equipment.**
- **Versatile G-E equipment is easily incorporated into existing system.**
- **Experienced G-E engineers help plan, co-ordinate, and install system.**

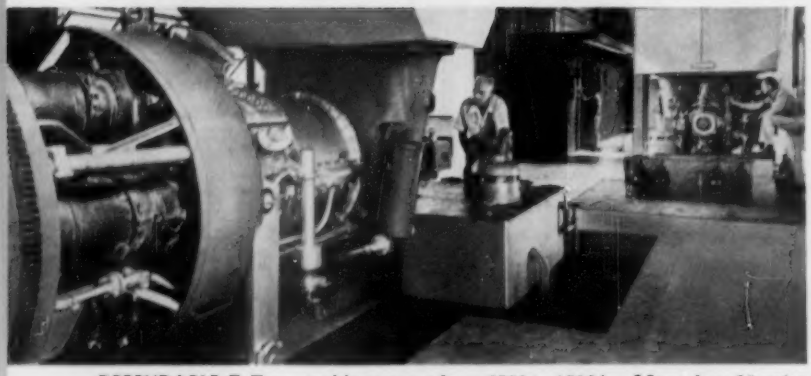
To learn more about these systems, equipment, and engineering services turn to the following pages. 681-3

MORE EFFICIENT ELECTRICAL SYSTEMS ▶

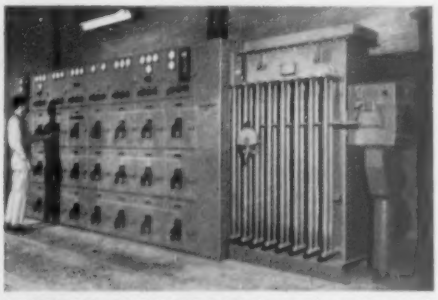
GENERAL ELECTRIC



UTILIZING PROCESS STEAM, G.E.'s complete range of steam turbine-generators provide electric power as a by-product, help maintain plant steam balance.



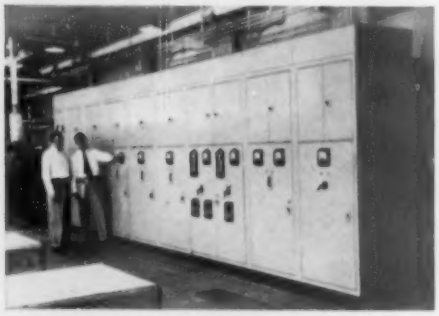
DEPENDABLE G-E gas turbines range from 6700 to 1700 hp. More than 55 units utilize exhaust heat for power generation and mechanical drive applications.



FACTORY ASSEMBLED G-E load center unit substations help cut installation time.

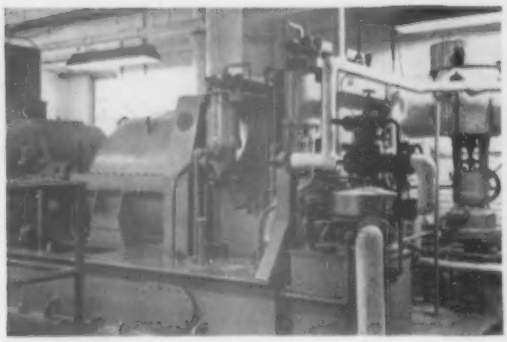
COMPLETE, COMPACT, G-E motor control centers provide centralized control in load areas.

MORE RELIABLE POWER DISTRIBUTION is available with G-E package substations which use co-ordinator transformers, metal-clad switchgear.



SAVE FLOOR SPACE with compact G-E Limit-amp control units.

DEPENDABLE G-E d-c motor generator sets are designed to operate in continuous service at top efficiency. Minimum of maintenance is a key feature of these sturdy generators built for long life.



ECONOMICAL MAINTENANCE is a key feature in design of G-E mechanical drive turbines.

RUGGED CONSTRUCTION of G-E Tri-Clad* motors make them ideal for all types of drive operations. Polyex insulation in motors 100-3000 hp gives 50% longer motor life.

*Reg. Trademark of General Electric Co.

G-E engineering services, equipment can give you . . .

More efficient electrical systems

MODERNIZING, EXPANDING, BUILDING? Whatever your plans, let experienced G-E engineers help plan a more efficient electrical system for you. They will work with you or your engineering contractors to give you correct answers to the following questions.

SHOULD YOU GENERATE OR PURCHASE POWER? G-E engineers will help make a "load" survey of your facilities, and recommend an economical solution to your particular power supply problem.

WHAT TYPE ELECTRICAL DISTRIBUTION SYSTEM SHOULD YOU INSTALL? The latest distribution system concepts will be reviewed with you by G-E engineers. They will help select and design a modern system to meet your individual requirements.

WHAT KIND OF DRIVE EQUIPMENT SHOULD YOU USE? Each application for drives in your processing lines will be individually examined by G-E engineers to assure that the proper drive is designated for the job.

WHERE CAN YOU UTILIZE AUTOMATIC CONTROLS? New developments in the field of automatic controls will be applied throughout your processing lines by G-E engineers.

Let your General Electric Apparatus Sales Representative get you detailed answers to these and other electrical questions. Contact him at your nearest G-E Apparatus Sales Office early in your planning stages. General Electric Company, Schenectady 5, N. Y. 681-3

PROTECT YOUR EQUIPMENT INVESTMENT ▶

Engineered Electrical Systems for Process Industries

GENERAL ELECTRIC

SIX G-E ENGINEERING SERVICES . . .

HELP YOU PROTECT YOUR EQUIPMENT INVESTMENT

1 **G-E APPLICATION ENGINEERING** helps you and your consultants design the right electric system for your plant.

2 **G-E ANALYTICAL ENGINEERING** helps attain the optimum electrical system for your application. Engineering experience backed up by electronic system analyzers save valuable design time.

3 **G-E PRODUCT DEVELOPMENT** laboratories design and test new equipment under tomorrow's conditions to meet your future demands.

4 **G-E FIELD-SERVICE ENGINEERING** helps you supervise installation, expedite start-up of your major electric equipment.

5 **G-E MAINTENANCE SERVICE** from 31 G-E Service Shops will repair and uprate your old equipment, help establish productive maintenance of your equipment, furnish emergency service.

6 **G-E PROJECT CO-ORDINATION** means on-time engineering, shipment, instal'ation of your electric equipment from preliminary diagrams through start-up.

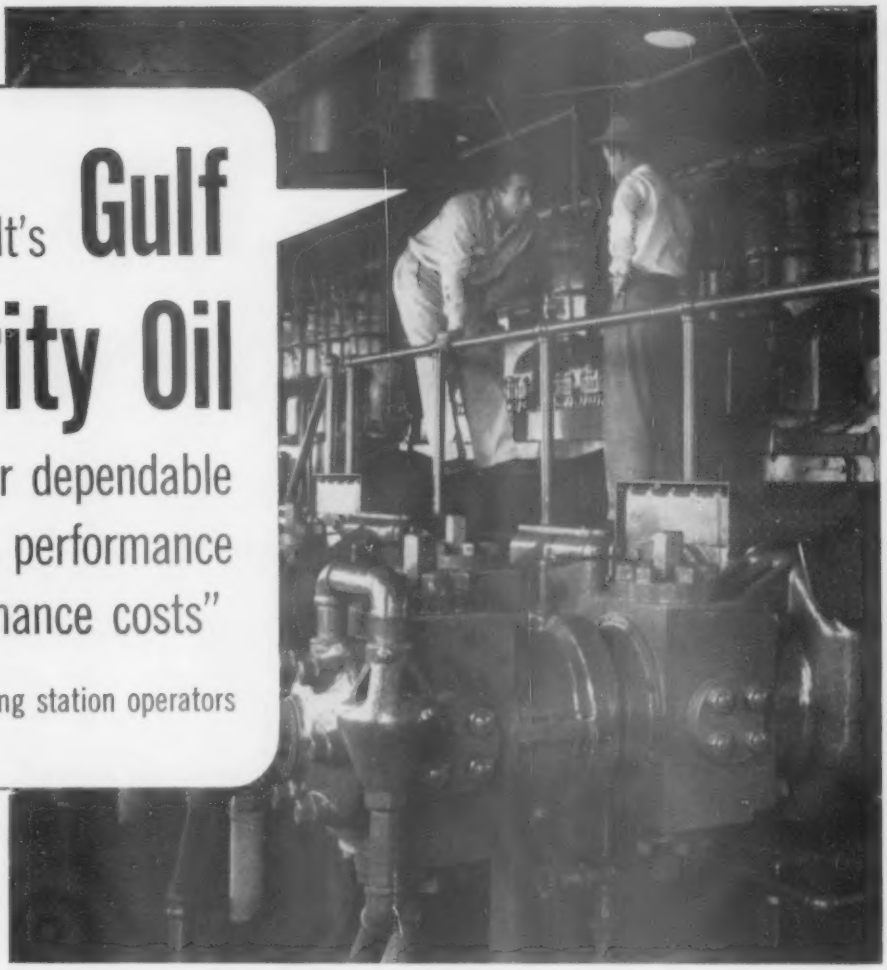
These valuable services are available to you with General Electric equipment. Contact any General Electric Apparatus Sales Office. Meanwhile, for the full story of G-E engineering services, write for brochure GED-2244, General Electric Co., Sect. 681-3, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

"It's Gulf Security Oil for dependable gas compressor performance and low maintenance costs"

say pumping station operators



Smooth, continuous operation is a must for these units in service at a South Texas gas compressor plant. They are responsible for the steady flow of essential natural gas through pipe lines to homes and industries as far north as Detroit and New York. Gulf Security Oil provides the sure, effective protection needed for cylinders and bearings in both engines and compressors.

You can depend on Gulf Security Oil to provide the proper lubrication that is so important to vital compressor units if operating troubles are to be prevented and maintenance costs kept low.

Gulf Security Oil has a record of outstanding performance in scores of gas transmission plants. After years of operation with this quality oil, the cylinders and piston rings of both the compressors and power assemblies show negligible wear. And few carbon deposits have formed on power cylinder ports and pistons.

If you are installing new compressor units, or feel that you're not getting the most effective lubrication possible for your present units, it will certainly pay you to try Gulf Security Oil. Contact your nearest Gulf Office and have a Gulf Sales Engineer call.

Gulf Oil Corporation • Gulf Refining Company

1822 GULF BUILDING, PITTSBURGH 30, PENNSYLVANIA

GULF

The finest petroleum products for your every need

Mathieson Activated Alum: *settles water treatment problems*

Quick-dissolving and fast-settling, Mathieson sulphate of alumina is a superior filter alum specifically designed for industrial water and wastes treatment. Its porous structure enables it to go into solution fast. The finely ground natural silicates aid coagulation, form heavier floc, and allow a greater volume to be processed in each treatment period.

In chemical plants, pulp and paper mills, petroleum refineries, Mathieson Activated Alum is providing efficient, economical water treatment and helping to solve sensitive wastes disposal problems. Mathieson's technical service staff is available for advice and practical assistance on application and handling of sulphate of alumina in all industrial installations.

See if Mathieson Chemicals can't settle your water and waste treatment problems. In addition to Activated Alum, Olin Mathieson is a major producer of chlorine, ammonia, sodium chlorite (chlorine dioxide), HTH hypochlorite products, sulphuric acid, hydrazine, caustic soda, and powdered and fused soda ash (PH-Plus). Your Mathieson representative will put you in touch with the men who can best serve you—or write today for complete information.

MATHIESON CHEMICALS

OLIN MATHIESON CHEMICAL CORPORATION

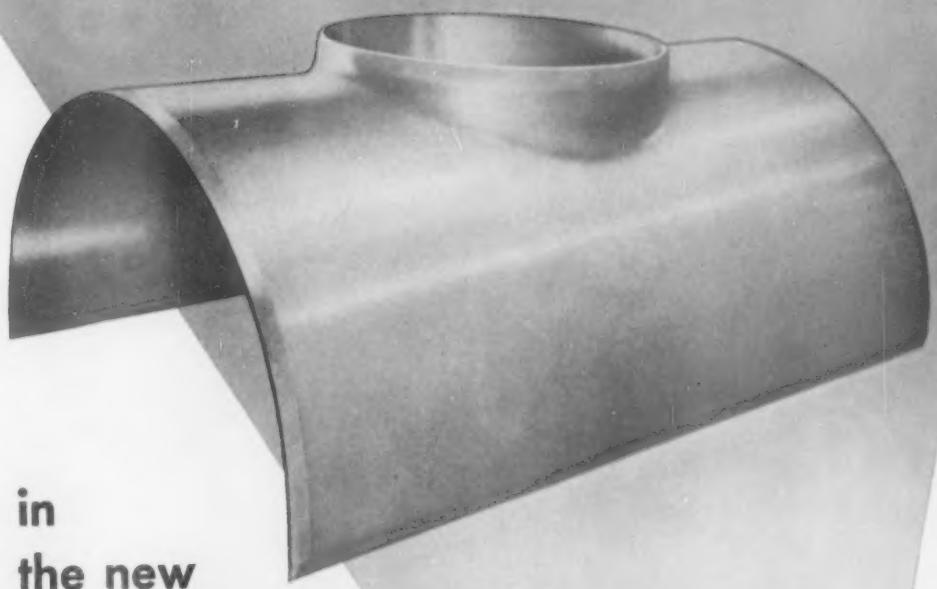
INDUSTRIAL CHEMICALS DIVISION • BALTIMORE 3, MD.

MATHIESON

3052

CAUSTIC SODA • SODA ASH • CHLORINE • SULPHURIC ACID • SULPHUR — AMMONIA • NITRATE OF SODA • BICARBONATE OF SODA • NITRIC ACID • SULPHATE OF ALUMINA • SODIUM CHLORITE PRODUCTS
ETHYLENE OXIDE • ETHYLENE GLYCOL • DIETHYLENE GLYCOL • TRIETHYLENE GLYCOL • POLYGLYCOLS • DICHLOROETHYLETHER • ETHYLENE DICHLORIDE • METHANOL • SODIUM METHYLATE • ETHYLENE DIAMINE

Here's what we mean by FLUED DOME



in the new acf-built DURADOME tank car

Notice that *smooth, unbroken curve* at the base of the dome—and the extra heavy-gauge steel throughout the full top center section. What used to be the weakest part of the tank car is now the strongest! It took a giant new million-dollar press to make that curve possible. Never before could a full top-center section of a steel tank car be perfectly *flued* to eliminate the weaknesses found in old-fashioned dome construction.

Only DURADOME tank cars give you the advantages of: *much easier cleaning . . . far better application of lining . . . greatly increased structural strength . . . unequalled resistance to corrosion.*

But there's more to the story—much more! Ask your Shippers' representative about the new *standardized underframe . . . all-welded insulation jacket . . . pressure-type construction.* You have a world of new benefits—at no extra cost—in the new, years-ahead DURADOME!

Specialists for over 35 years in the leasing, operation, maintenance and servicing of tank car fleets – now exclusive sales agent of acf *tank cars for industry.*

SHIPPERS SHPX CAR LINE

SHIPPERS' CAR LINE CORPORATION

30 Church Street, New York 7, N. Y.

A subsidiary of acf INDUSTRIES Incorporated

Chicago, Ill. • Houston, Tex. • San Francisco, Cal. • Milton, Pa. • East St. Louis, Ill. • Smackover, Ark. • Tulsa, Okla. • North Kansas City, Mo.

This is what dockmen call flexibility in a hose...

It's a hook-up of U. S. Rubber's H-1515

Notice the snakelike, flexible way this 12" I. D. hose drapes over and around objects on this oil-barge dock. This is one hose that's not bulky, heavy or stiff. It's a dockworker's dream of a hose.

Known as Amazon® H-1515, this United States Rubber Company hose is 2/3 lighter than conventional hose. It is so flexible and easy-to-handle that it sharply reduces make-up time to the header. And naturally, this light weight and extra flexibility reduce accidents. As for durability, U. S. Amazon, despite its light weight, takes rough treatment without damage. *It's in a class by itself.* Its ease of handling, quick make-up time *reduce loading charges.*

U. S. Amazon has been thoroughly proven by five years of Navy service and four years of oil company service. It is now used by every major oil company in America and most foreign countries. Made only by United States Rubber Company and sold through any of the 27 "U. S." District Sales Offices. For more information write address below.

US RUBBER

"U.S." Research perfects it..."U.S." Production builds it...U.S. Industry depends on it!

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes
Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

"The best mudline valve we've ever used is that new Rockwell-built *MUDWONDER*"

Here are some of the discoveries MUDWONDER users are making —quick, easy disassembly and re-assembly . . . easier, faster valve operation . . . no sanding-up . . . longer service life . . . less down-time . . . reduced maintenance . . . drop-tight shut-off . . . piping hook-ups stay together during inspection or part replacement—in other words, ECONOMY and RUGGED DEPENDABILITY.

Interchangeability of operating parts, a regular feature of all Edward valves, adds to MUDWONDER economy. The self-aligning gate of hard-chromed alloy steel and the one-piece seat insert of buna-N molded integrally to steel wear rings are the same in the 3000 psi WP (6000 psi test) and the 2000 psi WP (4000 psi test) MUDWONDER valves.

Replace troublesome mudline valves by ordering new MUDWONDER valves today.

Your favorite supply store has stock or can quickly fill your requirements from the Edward warehouses in Houston—1515 Fulton Street, phone CHarter 0863—or in East Chicago—1212 West 145th Street, phone East Chicago 231.

Edward Valves, Inc.
Subsidiary of
ROCKWELL MANUFACTURING COMPANY
1212 West 145th Street
EAST CHICAGO, INDIANA

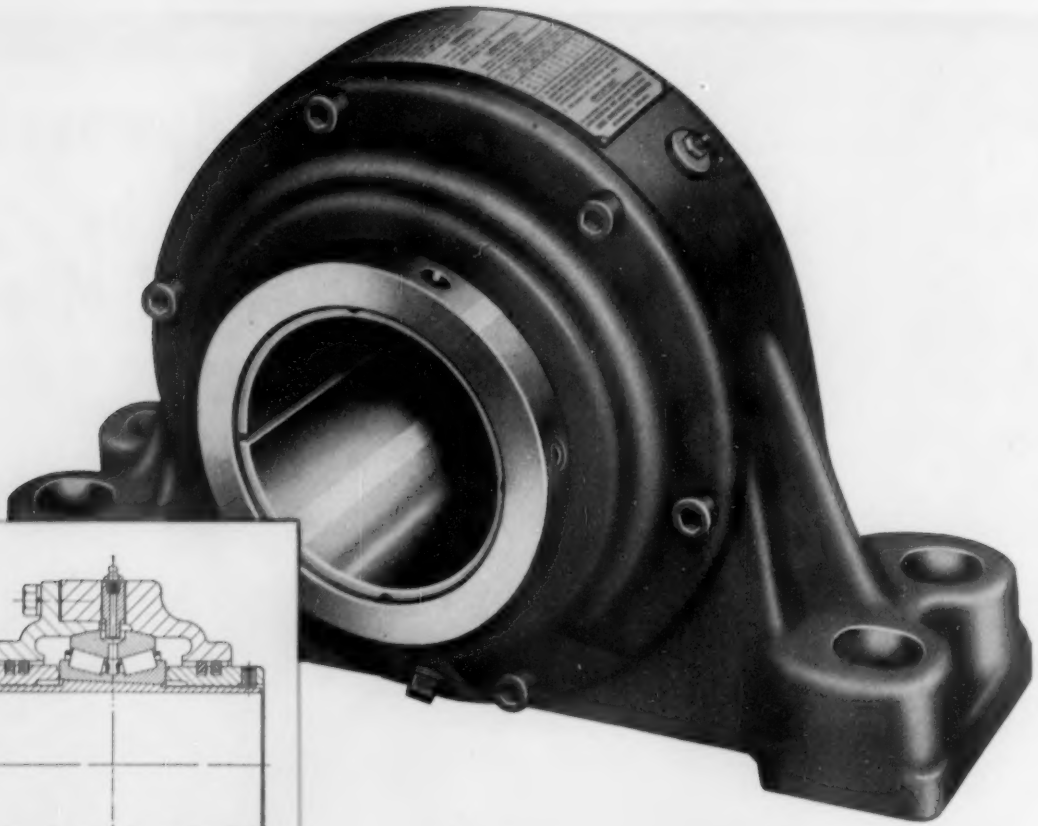
Send me your latest MUDWONDER catalog and price list for 3000 psi WP (6000 psi test) and 2000 psi WP (4000 psi test) mudline valves.

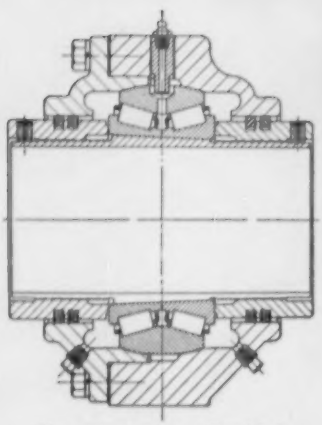
Name_____

Company_____ Title_____

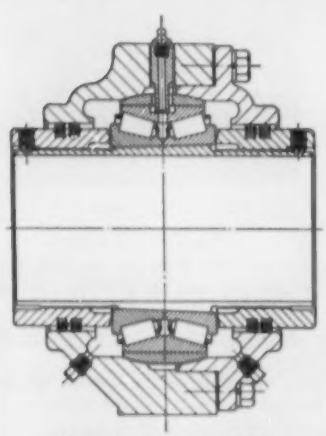
Address_____

City_____ Zone_____ State_____





Non-expansion type pillow block



Expansion type pillow block

How the new Dodge-Timken All-Steel pillow block gives you more load capacity in less space

HERE'S the new "All-Steel" pillow block that's making an outstanding record in heavy-duty applications. It takes up less space. It weighs less. Yet this Dodge-Timken All-Steel pillow block has tremendous load-carrying capacity. It is available in both expansion and non-expansion design. And it incorporates all the advantages of Timken® tapered roller bearings.

Because of their tapered construction, Timken bearings take radial and thrust loads in any combination. Line contact between rollers and races gives Timken bearings greater load-carrying capacity. And the Timken bearing in this pillow block is of new design, with tapered bore and self-aligning spherical outer race.

Timken bearings are made of the finest steel ever developed for tapered roller bearings—Timken fine alloy steel—and under normal conditions will last the life of the machinery with which the pillow block is used.

Timken bearings make any machine better. Always look for the trade-mark "Timken" on the bearings in the machines you buy or build. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

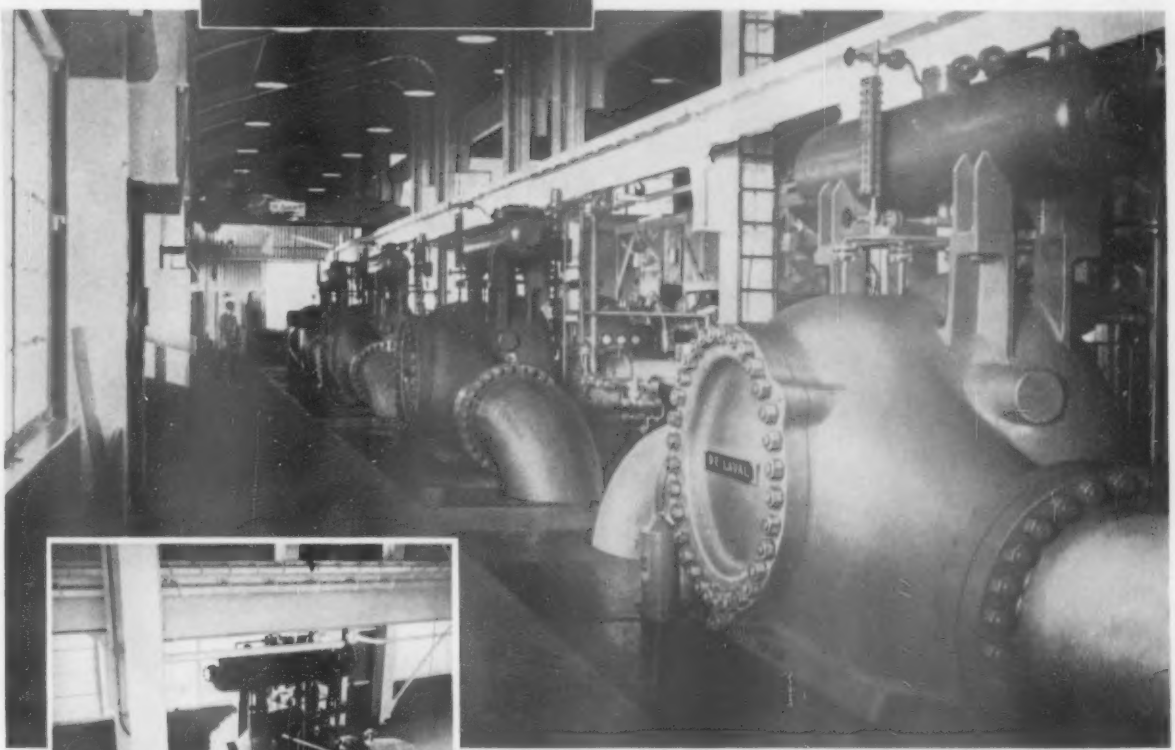
TIMKEN

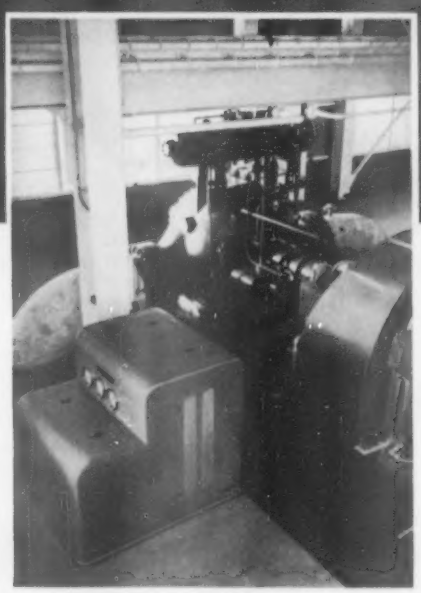
TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ◯ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST ◫ LOADS OR ANY COMBINATION

FOUR DE LAVAL CENTRIFUGAL COMPRESSORS *in Tescott, Kansas station of Northern Natural Gas*





For easy installation, De Laval pipeline compressors are designed in two packages: (1) The machine plus the emergency seal tank, (2) The auxiliary console which contains the filters, pumps, coolers and other accessories.

Here's more proof of the efficiency and dependability of De Laval centrifugal compressors for high pressure gas transmission. This Tescott, Kansas station of the Northern Natural Gas Co. has four De Laval centrifugal compressors in series.

The station flow is 930 M^2SCFD, station inlet pressure 477 psig and discharge pressure 745 psig. *By changing the impeller and a few minor parts, these units can handle 1,100 to 1,200 M^2SCFD.* Three identical De Laval compressors are on the job in the Macksville, Kansas station of Northern Natural.

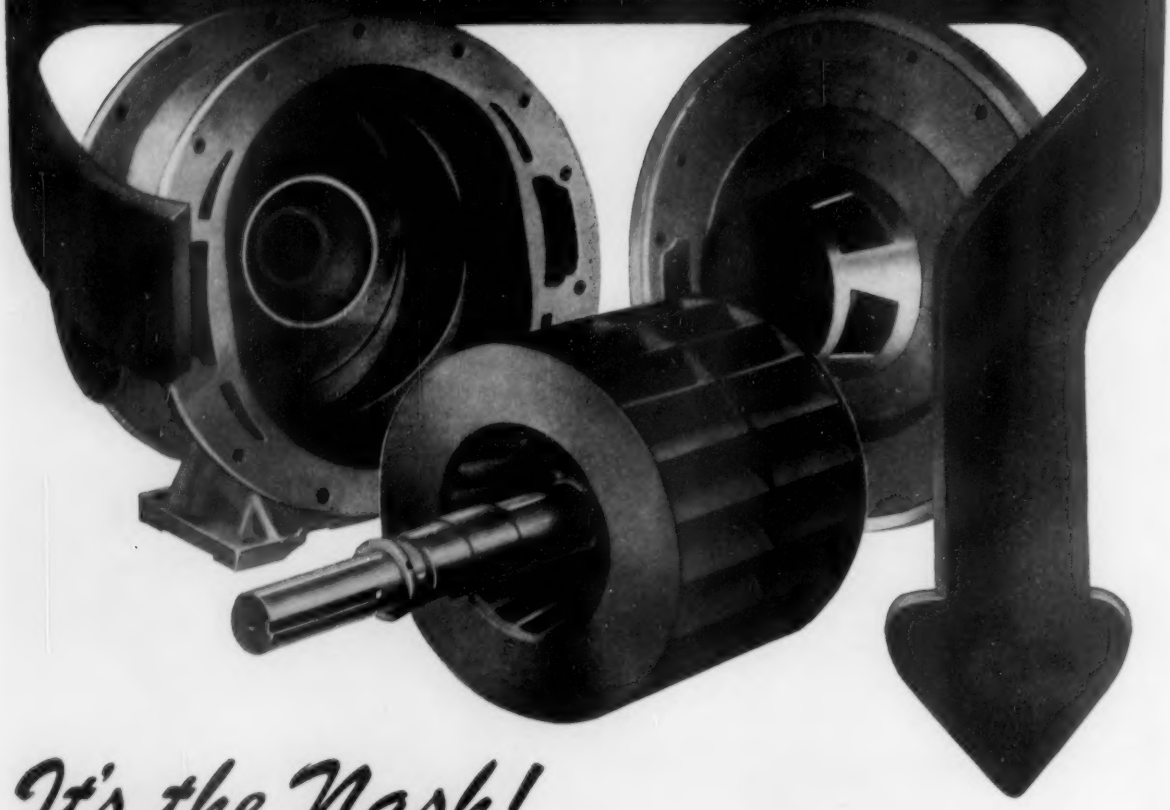
De Laval centrifugal compressors offer important engineering features. • Pressure contact shaft seal eliminates gas leakage. • Construction is heavy and rigid throughout. • Units have high load carrying capacity. De Laval units, totaling more than 200,000 hp, are now in operation on major pipelines.

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY
810 Nottingham Way, Trenton 2, New Jersey

DL209

This Simple Compressor Meets the Complex Needs of a Changing Petroleum Industry



It's the Nash!

Here is a compressor presenting advantages found in no other device. Nash Compressors have only one moving part, rotating without metallic contact with the pump casing. No internal lubrication is required. Yet they produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure.

There are no valves, gears, pistons, sliding vanes, or other complicated wearing parts in a Nash. Compression is secured by an entirely different principle of operation. Because of this, gas pumping problems difficult with ordinary pumps are often easily handled by the Nash. For example, Nash Pumps are standard equipment in the Synthetic Rubber Industry, where they have met the needs of new and difficult processes.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. They maintain original performance over long periods. Service is assured by a nationwide net-work of Engineering Service offices. Instructive bulletin shows how they operate. Write for it.

One moving part.

No internal wearing parts.

No valves, pistons, or sliding vanes.

No internal lubrication.

Low maintenance.

Slugs of liquid entering pump do no harm.

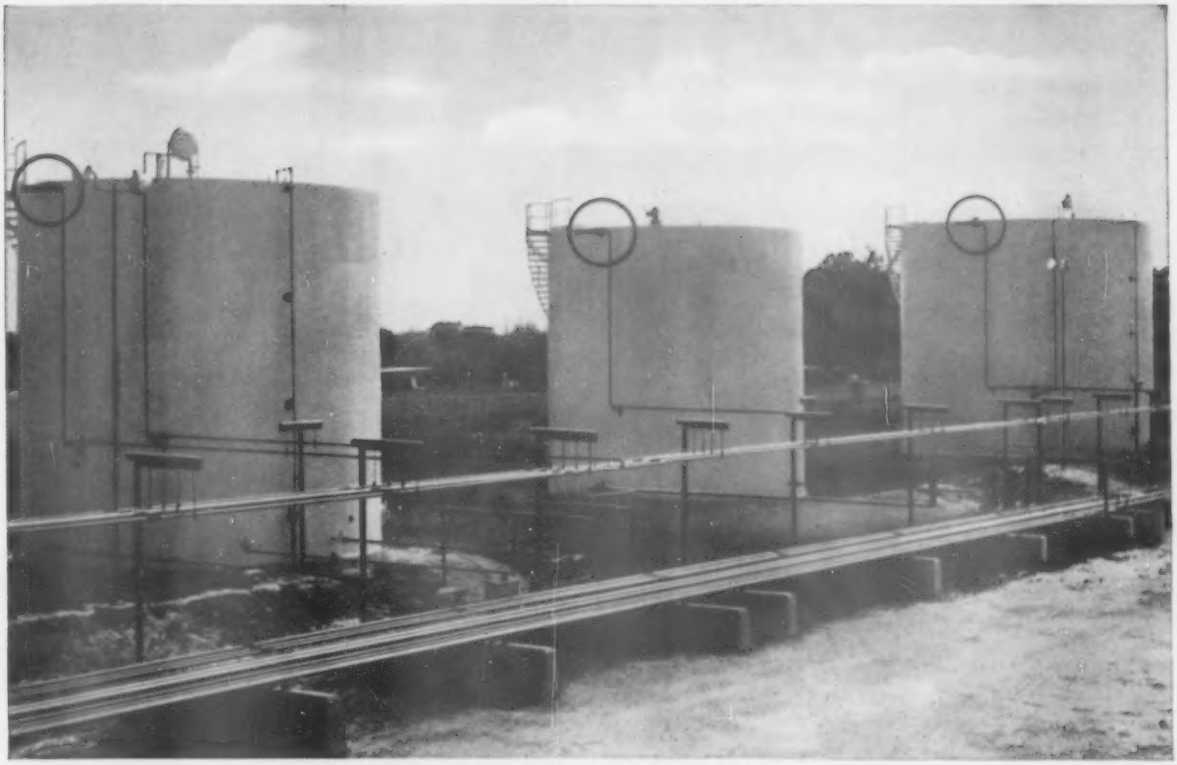
Non-pulsating pressure.

Saves floor space.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

311 WILSON, SO. NORWALK, CONN.



Rockwood Double Barrelled Foam Maker Chambers (circled) guard oil storage tanks in a southern refinery above.

The bubbles that keep oil safe

The tube-like objects circled in the photograph above have a special way of generating bubbles that safeguards the oil within the storage tanks.

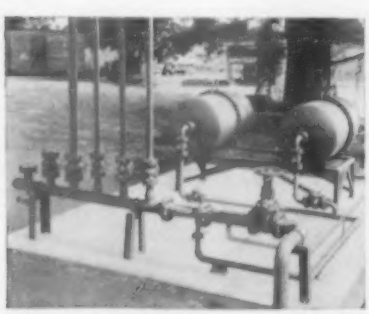
Should fire break out, these tubes — Rockwood Double Barrelled FOAM Maker Chambers — will swiftly pour a smothering FOAM blanket over the flames, controlling and extinguishing the fire. What's more, they pour a denser type of Rockwood FOAM blanket than ordinarily produced.

Inside each tube are two concentric barrels, one within the other. Internal impinging jets discharge into these barrels, dynamically mixing air, water and FOAM into a finer bubble structure than ordinarily possible and thus producing the extra-dense blanket that keeps oil safe.

This patented construction of Rockwood Double Barrelled FOAM Maker Chambers is typical of the careful way in which Rockwood engineers every detail of a Rockwood SpotPROTECTION System. These systems take the danger out of danger "spots", protect lives, property, money. Take advantage of them for your own protection.

ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses



These Rockwood SpotPROTECTION Liquid Storage Tanks contain Rockwood FOAM. A balanced pressure proportioning system automatically proportions the FOAM into the water. This properly balanced mixture is then fed into the system that protects the tanks.

Rockwood Double Strength Foam clings to metal surfaces as an insulator — FOAM Liquid flows freely at sub-zero temperatures. Excellent for extinguishing fires in gasoline, benzol and other highly volatile liquids as well as ordinary combustibles.

SEND FOR THIS INFORMATIVE BOOKLET

ROCKWOOD SPRINKLER COMPANY
Portable Fire Protection Division
364 Harlow Street
Worcester 5, Mass.

Please send me your illustrated booklet on Rockwood fire-fighting products.

Name _____

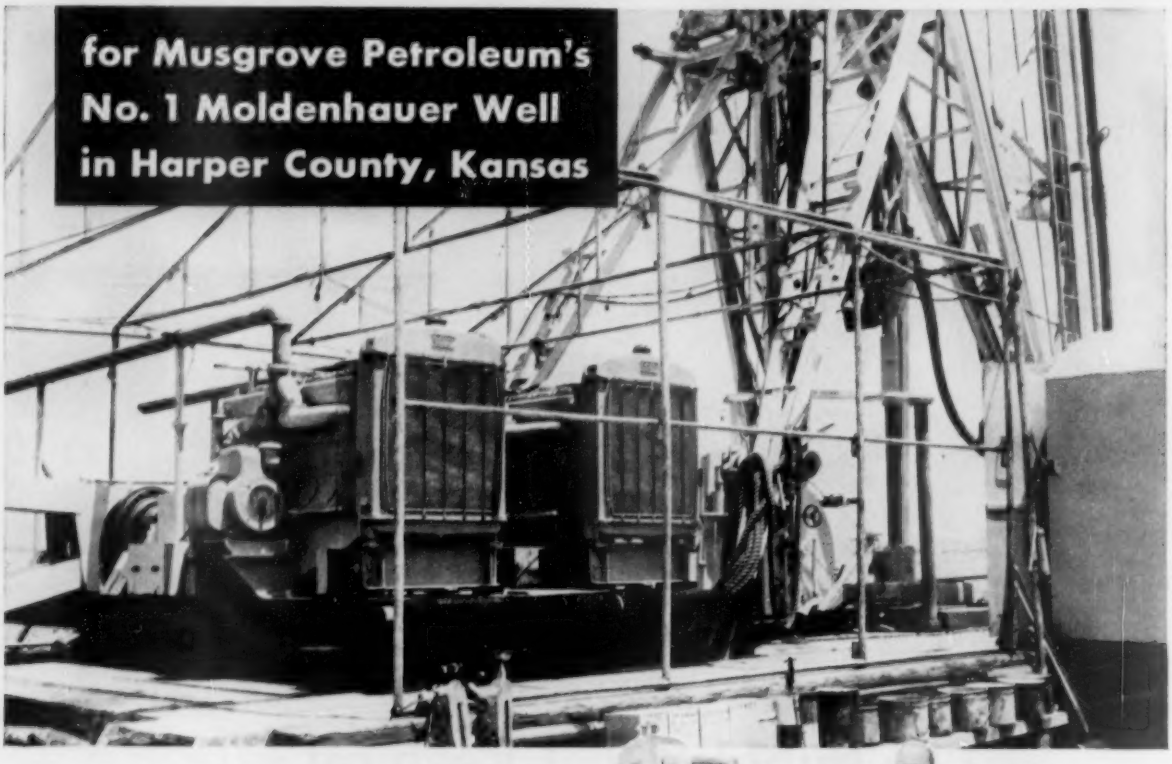
Title _____

Company _____

Street _____ City _____

Zone _____ State _____

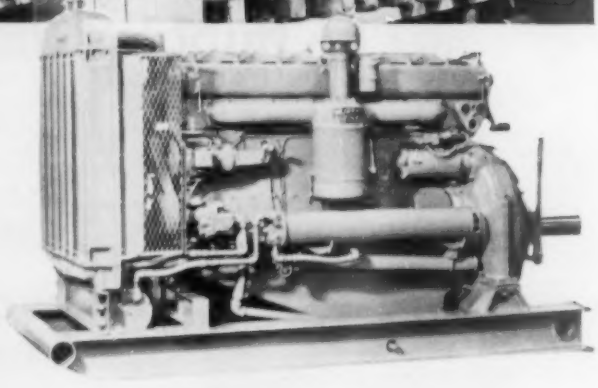
MURPHY DIESEL POWER



In what may prove to be a major discovery, Musgrove Petroleum Corp., Inc. shows a drawdown of 3000 barrels of oil a day from its No. 1 Moldenhauer, 4½ miles southwest of Harper, Kans.

Musgrove's No. 3 rig, pictured above, was used to drill to a total depth of 5,052 ft. in 23 days. This rig is powered by two 200 H.P. Murphy Diesels.

The growing popularity of Murphy Diesels in the oil country results from an exclusive combination of design features that assure dependability, economy and freedom from downtime. Ask your Murphy Diesel Dealer to tell you the whole story.



Heavy duty Murphy Diesel Engines are available in sizes from 90 to 240 H.P.; Generator Sets from 60 to 154 K.W., marine engines and auxiliaries from 90 to 225 H.P.

MURPHY DIESEL COMPANY

5305 W. Burnham St., Milwaukee 14, Wisconsin

FACTORY BRANCH—Sales, Parts, and Service: 113-117 So. Elwood St., Tulsa, Oklahoma

325

MURPHY DIESEL

SEE YOUR MURPHY DIESEL DEALER, TODAY—

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PETROLEUM CHEMICALS DIVISION
NEWS

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April ★ One of a Series of Interest to the Petroleum Industry ★ 1955

THE "SIGN" OF A GOOD CUSTOMER

This booklet can help your dealers to recognize it . . . and profit from it

Credit customers, as you know, are generally *good* service station customers. They buy, for example, an average of *three gallons more* gasoline than cash customers and spend almost a *dollar more* per sale.

But many service station dealers and attendants fail to realize the value to them of these important customers. So to help your dealers get a better picture of the credit sales potential, we suggest that you distribute the above booklet to them. Entitled "A look at the credit customer," it is No. 3 in Du Pont's new "Looking through the windshield" series.

Any Du Pont Petroleum Chemicals Division representative or regional office will give you sample copies of these booklets . . . and cost information on ordering them in large quantities.

New Movie to Help Your Dealers Cope with KNOCK Complaints

"When the customer says 'KNOCK' " is the title of a new movie that offers your dealers a quick visual education on how to answer knock complaints in a salesmanlike way.

It is a 15-minute live-action sound movie in full color. Introduced by Tom McCahill, noted automotive writer and car authority, the film was produced by the Du Pont Petroleum Chemicals Division for oil company use.

DRAMATIC PROOF of the mechanical, natural and human causes of knock are clearly demonstrated in the movie by the chassis dynamometer.

The film explains dramatically the seven most common causes of knock—none of which are caused by gasoline quality. It gives dealers a clear, concise picture of how such things as temperature and altitude, poor mechanical adjustments, and bad driving habits cause knock. To help demonstrate these points the two-story chassis dynamometer at the Du Pont Petroleum Laboratory is shown in action in the film.

Familiar situations

To dramatize the causes of knock and make them readily understandable to dealers and customers, typical motorists driving several different popular makes of cars are shown encountering engine knocking problems under familiar, everyday

OVER

OCTANE NUMBERS— *Where are they going?...*

Here's how the Du Pont Quarterly Motor Gasoline Quality Survey can be of real value to you for long-range planning.

The average research octane numbers of all gasoline produced by the American petroleum industry have been steadily rising since the end of World War II. This average has risen from 84.3 in 1949 to 88.3 in 1954. The above figures are based on averages for both "regular" and "premium"—weighted on an area-grade-volume basis.

Of particular interest is the fact that the rate of increase during 1954 was nearly twice the rate of increase during 1952 and 1953.

And, based on the many new catalytic reforming facilities expected to come into operation during 1955, no slackening in this rapid rate of increase in octane numbers is expected to take place during this year.

The above information gives you an over-all picture of the national trend. But how do you relate it to your own individual situation? . . .

Right in your copies of the Quarterly Du Pont Motor Gasoline Quality Survey are all the details you need for applying the national trends to your own local marketing situation. With a number of previous issues in front of you, you will notice that almost every city or area tends to keep its own relative position in the over-all trend.

It is in analyzing and forecasting these long-range trends on a marketing area basis that your Du Pont Quarterly Survey can be most valuable to you. And each year, as new reports are added to the survey, it becomes more valuable as a planning aid.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED "Knock" Movie

driving conditions. This part of the movie also dramatizes the reactions of many customers whenever they hear an engine knock . . . a reaction which frequently, and erroneously, causes them to blame the gasoline rather than the true cause of the knock.

The problem of Ed Gilbert, a character in the film, is typical. Ed is shown driving his '54 Ford sedan down to the plains from a high mountain area where his home is and where much of his driving is done. As soon as he starts pushing his car across the low-level plains country, the engine begins to knock.

And what does Ed do about that knock?

He immediately decides the gasoline brand he's been using is no "blankity blank" good. And he, therefore, decides to switch his brand immediately.

Who's the real villain?

But will the switch really solve Ed's problem? Of course not. The villain causing the knock is the change in altitude. And the solution to this problem is a proper adjustment in the carburetor setting.

Other common causes of knock are graphically and dramatically explained in the movie. Examples of knock caused by changes in humidity and temperature . . . by mechanical factors such as an over-advanced spark, or a faulty water pump, thermostat or fan belt . . . and by poor driving habits are all included.

Good public relations

The more your dealers know about the common causes of knock, and the more of this knowledge they are able to pass along to their customers, the less you and your products are likely to be blamed for engine knocks.

The new Du Pont movie, "When the customer says 'Knock'," can help you tremendously in this important work. What's more, with its live-action drama and easy-to-understand dynamometer demonstrations, it is also suitable for showings to customer groups.

Available to you

A limited number of prints of this new movie are now available for your use. More are being made. Before you order yours, we suggest you contact our local representative for an advance showing.

ASSISTANT GULF COAST REGIONAL MANAGER

BARRY V. CORNWALL is now assistant manager for the Du Pont Petroleum Chemicals Division's Gulf Coast Region with headquarters in Houston, Texas. He was recently transferred to this post from the Division's Eastern Region, where he also served as assistant regional manager.

Since 1929, Mr. Cornwall has been continuously associated with the Du Pont Company. Following his first assignment as a technician in the service laboratory of the Dyestuffs Division, he became a salesman for the Alcohol Division's anti-freeze and industrial solvents. He later became assistant sales manager of the Alcohol and Camphor Section. He then joined the Petroleum Chemicals Division in 1952 as technical assistant to the director of sales.

Mr. Cornwall was born in Winnepeg, Canada, and graduated from Clemson College in South Carolina. During World War II, he served four years in the U. S. Army.

Write for this new book on Du Pont Lube Oil Additives

Polymeric lube oil additives combining effective low-duty detergency and V. I. improver qualities are a new and revolutionary development. And, until now, adequate information on their properties, application, and methods of addition has not been readily available.

A comprehensive discussion of these additives, however, is now available in a single book. This book, "Du Pont Lube Oil Additives 564 and 565" covers the basic aspects of this new development . . . including physical properties, low-temperature detergency and diesel detergency; effect on inspection data and bench test performance of oils; viscosity index improving characteristics; low-temperature wear properties and bearing corrosion characteristics. Details on toxicity and handling are also included.

The book is well illustrated with photographs of parts from test engines and detailed performance charts.

Copies are readily available from

any Du Pont Petroleum Chemicals Division representative or regional office listed below.

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A-9140

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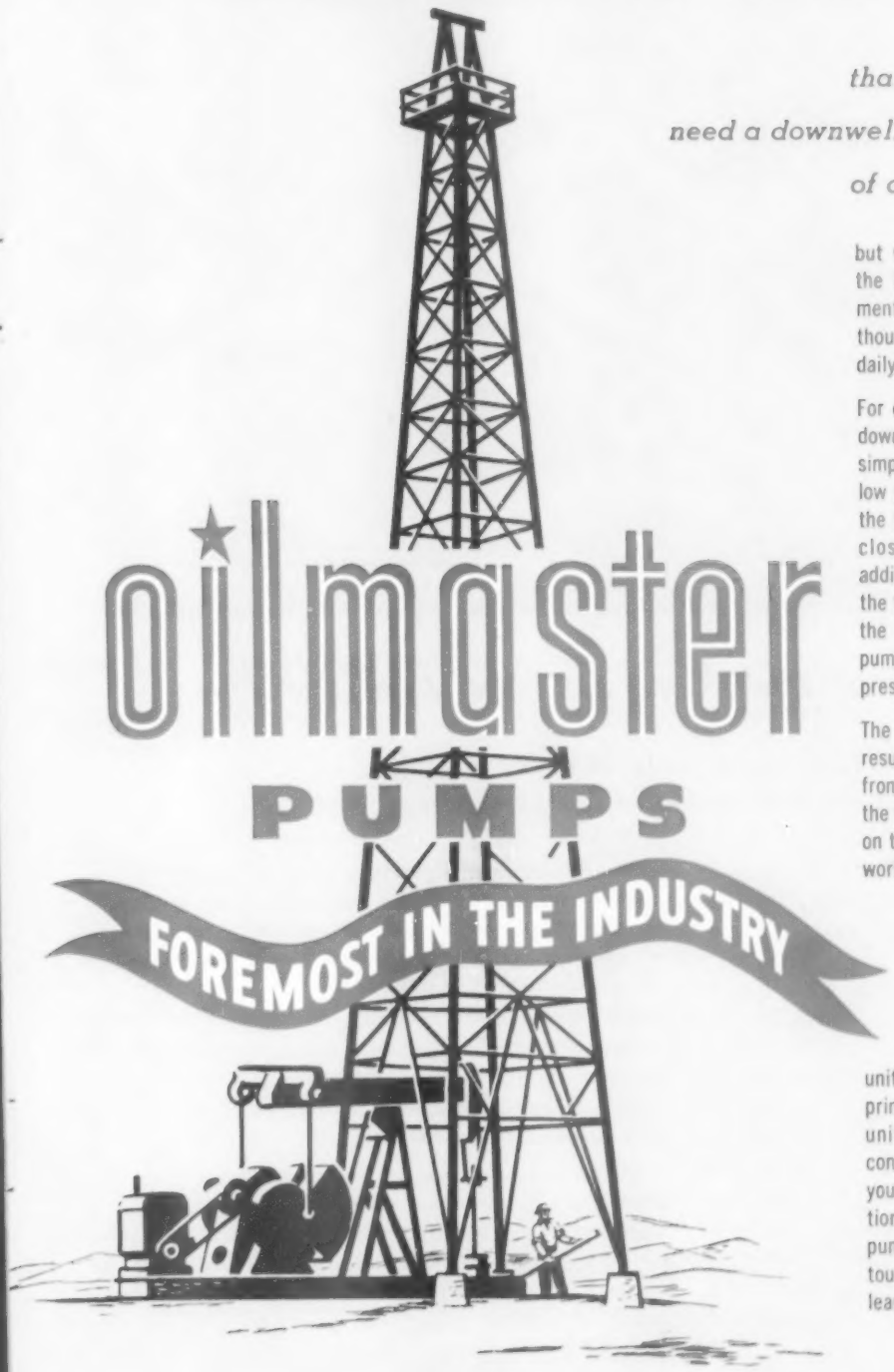
WE HAVE HESITATED TO SUGGEST...



that an oil well might

need a downwell compressor instead

of a downwell pump...

but we have become increasingly aware of the limitations of a single acting displacement pump for wells that must produce many thousand cubic feet of gas along with the daily production of oil. Solution...

For once, the long, slim shape required of a downwell pump worked to our advantage. We simply replaced the pull rod with a long hollow polished rod, and terminated the top of the pump barrel with a short packoff barrel closely fitted to the hollow rod. Then by adding an extra traveling valve to control the fluid flow through the hollow rod, we had the hybrid we were after—a compounded pump that would act as a two stage compressor on gassy fluids.

The combination achieved some interesting results. With the top of the plunger protected from the high pressure fluid in the tubing, the pump couldn't pound fluid. The fluid load on the hollow polished rod did the necessary work of compressing the gas and transferring the fluid from the pump barrel to the annular chamber on the downstroke, and in addition it kept the rods in tension.

We could go on — lower load range on the rods meaning lower torque on the unit gear box and less horsepower from the prime mover. No more gas lock meaning more uniform production, less destructive heat converted in the pump. But we suggest if you are interested in more efficient operation than you can obtain from a conventional pump in gassy or foamy wells that you get in touch with your Oilmaster representative and learn all about the

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Patents Applied For

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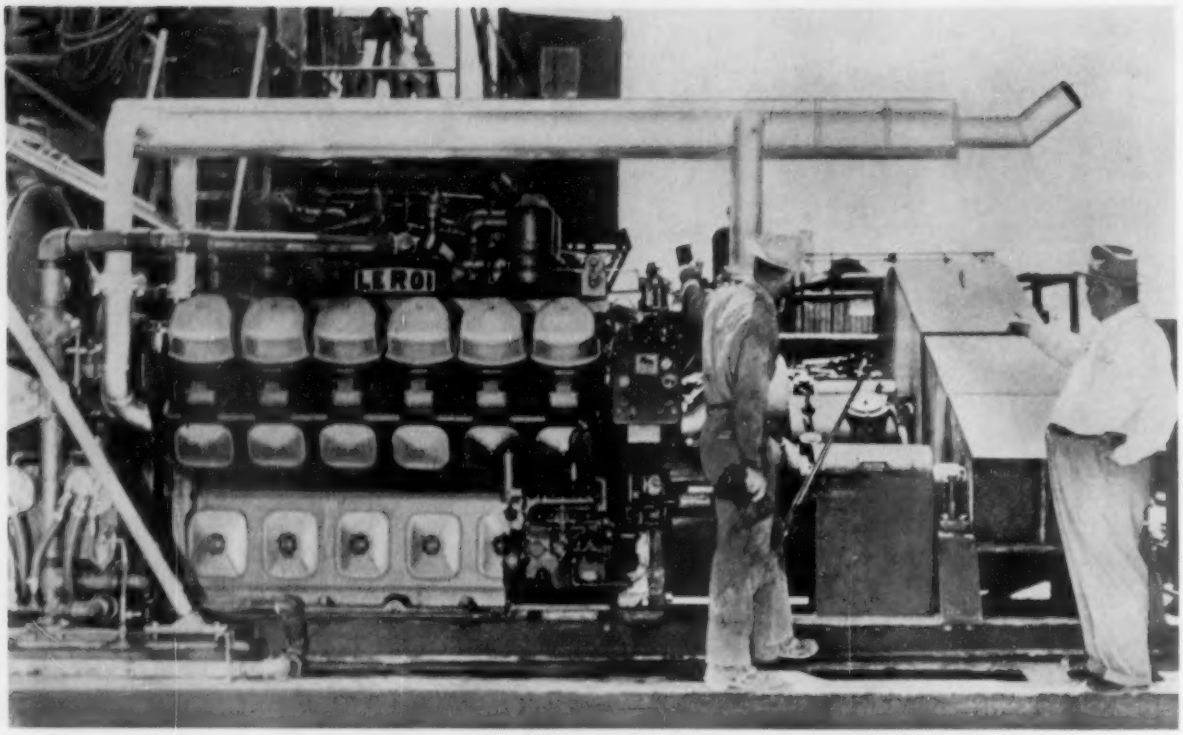


Announcing the New Le Roi L 4000

...a 635-hp engine only 164 inches long
— that has been field-proven for more than a year

ALREADY many Le Roi L4000 (4000 cu. in.) engines are in use on practically all oilfield applications — drilling, pipeline station, gas booster, generator, etc.

In every case, the performance of the L4000, after better than a year's service, has been outstanding — so outstanding that we thought you would want to know more about this engine.

Basically the Le Roi L4000 is patterned after our L3460. That means it's a valve-in-head V-12 that puts a lot of power in a small space to give you more horsepower per dollar. Because it's a compact, high-output engine, designed with short stroke you get greater horsepower and speed without compromising engine life.

Also, like the L3460, the L4000 has lightweight pistons, short-radius rotating parts, hydraulic tappets, crankshaft vibration dampener, sensitive controls. These modern features mean hair-trigger response to load demands, and smooth operation — so smooth you can balance a coin on the engine while it's running.

Other advantages are: good fuel economy, conservative rating, wide speed range up to 1350 rpm, easy accessibility, and, of course, easy installation — because the L4000 is so compact.

There's not space enough here to tell you all about the 635-hp (max.) L4000. If you wish to know more about this truly modern, high-output engine that has already stood the gaff of oilfield service, just drop us a card — we'll send you our latest bulletin.

P-135

LE ROI *Division of Westinghouse Air Brake Co.*

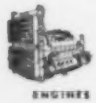
Milwaukee 14, Wisconsin

PORTABLE AIR COMPRESSORS

TRACTAIR

STATIONARY AIR COMPRESSORS

AIR TOOLS


ENGINES

In Every Bethlehem Swivel— MORE OIL...

CLEANER OIL...TO VITAL BEARINGS

Nothing so affects the life of a swivel as the lubrication system. When parts rotate at high speed, inadequate supplies of oil reduce bearing life. And when in addition the oil carries dirt and abrasive sediment into the bearings—well, that's the same as signing the death warrant.

But there are no such worries with Bethlehem's great new swivels. Into each one of them is built an oversized oil reservoir, with plenty of surplus capacity. And even better, these units have a circulation system that directs any foreign matter *away* from bearings and *into* the sump, where it can do no harm.

This means three direct advantages to the user: lower maintenance costs, reduced shutdown time, and longer overall life.

There are other features, too, that make these new units the soundest of all swivel buys. One you should note particularly is the high main-bearing capacity—the only *true* measure of rating. Another is the double-life washpipe, which you can lock at either top or bottom, thus dividing wear on both washpipe and packing.

Ask for full details of these l-o-n-g-lasting swivels. There is one for every drilling assignment, shallow or deep.

Bethlehem swivels available in these four sizes:

No.	Main bearing cap., 100 rpm	Cap. oil reservoir gal.	Pct increase oil cap. over previous model
60 B	64 tons	5	25
100 B	123 "	6	20
150 B	170 "	8	60
300 B	302 "	20	33 ⅓

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- Tools to reach hard-to-get-at places
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INQUIRIES INVITED ON FORGINGS OF ALL TYPES

Eastern Factory, Jamestown, N.Y.
Canadian Factory, London, Ont.

They Say—

Westward, Whoa!

Dear Sir:

In looking over your March 14 issue, I came to the upper left-hand corner of page 86 showing a map of the proposed 36-in. gas line. As I gazed at this picture I must have enjoyed the same feelings of exhiliration experienced by Balboa when he climbed the last mountain and had his first glimpse of the Pacific Ocean.

We are planning to spend our vacation this summer on the New Jersey seashore and I can't tell you with what excitement we are looking forward to taking a dip in the Pacific Ocean, which I have never seen.

Thank you for contributing so much to my pleasure and anticipation.

Wirt R. Robinson
Assistant Manager
Distribution Division
Sun Oil Co.
Philadelphia.

Editor's Note: Reader Robinson's pleasure and anticipation isn't exactly matched here at Tulsa headquarters of the Journal. In fact, the rest of the editorial staff is still trying to find out from Art Director C. Dudley Johnston just what happened. Johnston is finding it hard to make excuses because he can't claim a mixup in directions—the rest of the map is correct and the north direction arrow is pointed north.

Helped Pioneer Pipelining

Dear Sir:

In your March 14 issue (page 123), the report by Messrs. H. Fanner and W. O. Martin on the Velasquez field in Colombia especially interested me.

The map showing the location of the field with relation to the old Barrancabermeja field and the Andean National Pipe Line stirred nostalgic memories within me. I was one of the pipeliners who laid the first joints of that historic line in April of 1925. Our spread went on to build part of the line and tie in the last joint of the original line, flanging up with a section which another spread had laid to meet us. Pictures were made of the flanging up—an old pipeliner's term for the completion of any job . . . It was, of course, a screw line.

So when Texas Petroleum Co. builds its line, which must relatively parallel the Andean line, construction by modern methods will be quite a contrast to the crude, tedious, and laborious meth-

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chosen for quality in geophysical explorations...

W Series...rugged heavy duty watertight

well logging...

K Series...for sensitive instrumentation

pumping engines...

GB Series...for pumping engine starting

Cannon Plugs are important components affecting the portability, flexibility, and better maintenance of oilfield electrical and electronic equipment.

In geophysical exploration, well logging operations, Cannon's Series P, X, XL, K, AN, DP and W plugs are widely used. For power supply, engine starting and high current applications, the rugged GB Series provides a wide variety of services. The petroleum industry has found that Cannon Plugs increase operational efficiency wherever they're used. For an easy-to-understand summary of the vast Cannon line, send for the Cannon Plug Guide, or AN, K, GB Bulletins.

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Refer to Dept. 164

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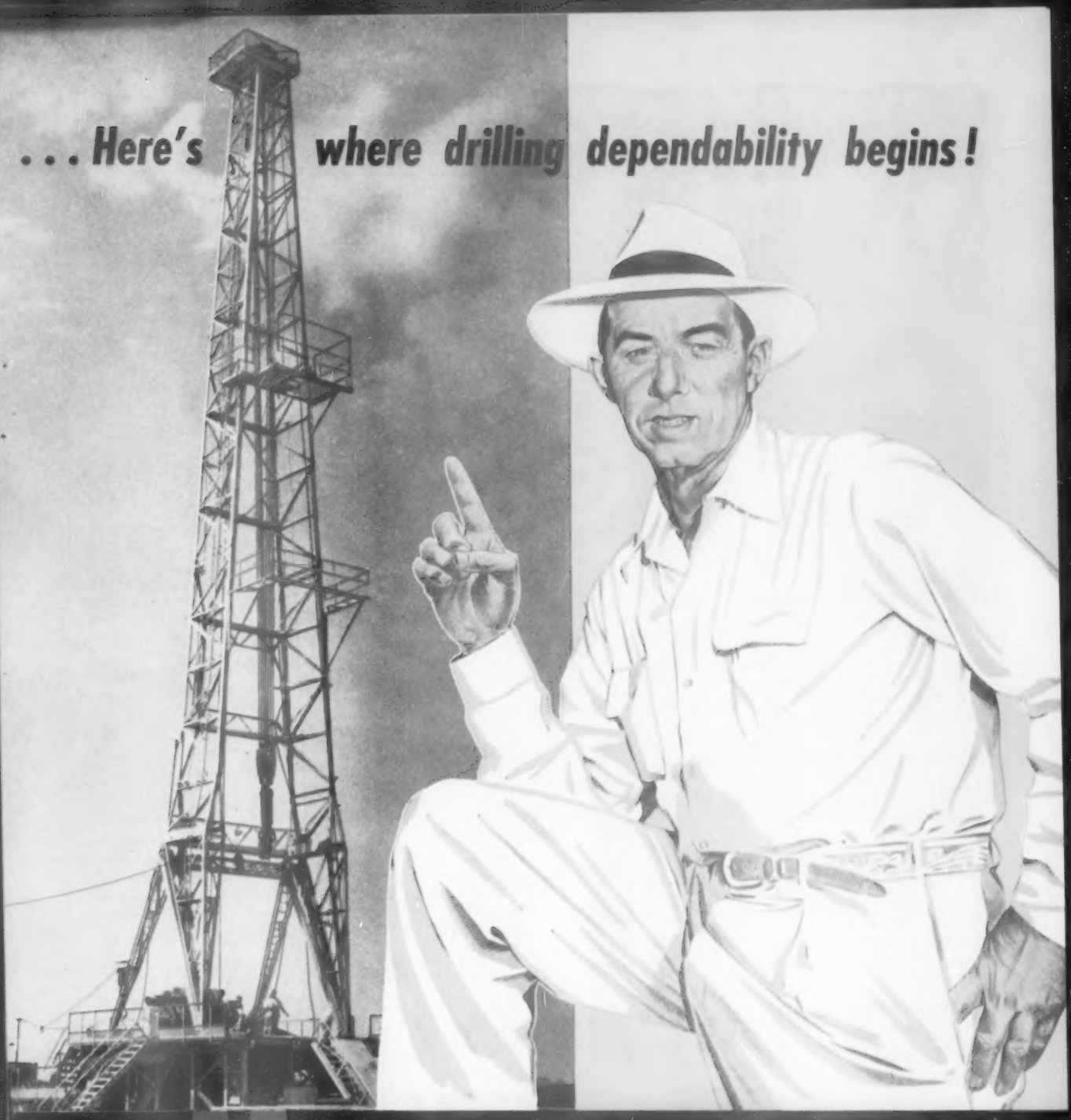

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SERVING THE OIL INDUSTRY 15 YEARS

ods used in those long-gone days of 30 years ago.

I could write a book about my experiences on that job. But let this suffice for now.

Robert S. Notestine
(Ajax '30-'39)
Socony-Vacuum Oil Co.
Eastern Pipeline Division
Plainfield, N. J.

Editor's Note: The Journal is very glad to hear from Reader Notestine and his part in building Andean National pipeline. The two trans-Colombian pipelines—Andean, connecting to El Centro field, and South American Gulf Pipe Line, connecting to Barco concession—rank as two of the pioneering major trunklines in the oil areas outside the United States.

Offshore Allowables

"The practice of granting higher allowables at greater depths recognizes increased drilling costs. How simple to expand this principle to recognize in the allowables the increased costs of offshore drilling and operations. The State of Louisiana has done this on occasion, but recently to an inadequate extent.

"The State of Texas recognizes the propriety of rewarding the discoverer of a field with a discovery allowable extending to the first five wells drilled in a field and increasing with depth. Right now, the offshore industry needs an adequate discovery allowable for the first 5 years of production, not for the production of the first five wells . . ."

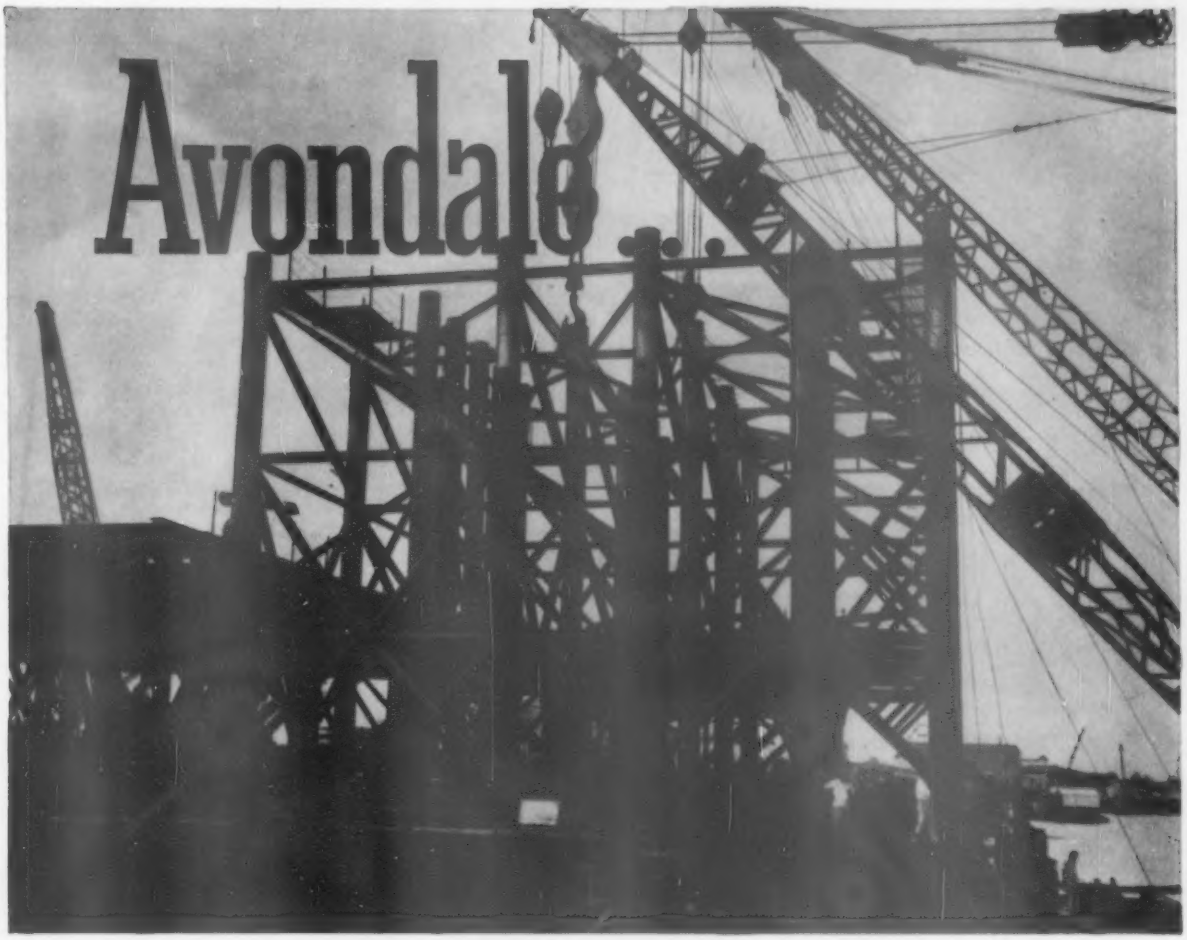
Ira H. Cram, senior vice president, Continental Oil Co., in an address in New Orleans before the spring meeting of the southwest district, Division of Production, American Petroleum Institute.

How to Dry Up Gas Supply

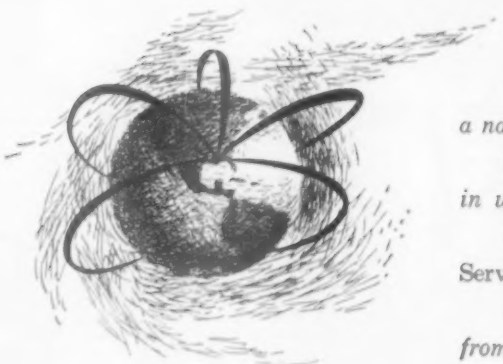
"Senator Douglas of Illinois, who used to teach economics, practices a peculiar brand of it. He has introduced into the Senate his own version of federal regulation of the wellhead price of natural gas. Undoubtedly he would call it the application of 'liberal' economics to natural-gas pricing, but it more accurately could be described as playing fast and loose with the interests of the gas consumers it professedly is designed to protect.

"Senator Douglas would have the Federal Power Commission instructed by law to fix the producer's rate for natural gas on the basis of actual costs of properties involved in production. This would discard the FPC 'fair field price' formula, which is the rate set by the highly competitive condition in the gas industry.

"The method advocated by the Illi-



service • integrity • efficiency



Avondale barges, towboats, tugboats, drilling barges, personnel launches and offshore drilling platforms have made a name for themselves within the Oil Industry as being tops in Quality and Performance. Avondale's Service, *the manner in which Avondale carries out a job to the letter, has made customers return to Avondale time and time again. Couple* Service *with the two words,* Integrity *and* Efficiency, *and you have the ultimate in what the Oil Industry needs and wants from a company rendering service to them . . . .*

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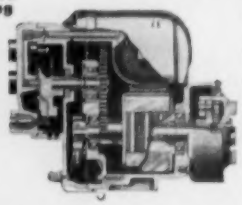
Switch to Fairbanks-Morse Super Spark Magnetos and forget about ignition failures. See your Fairbanks-Morse service station or distributor or write Fairbanks, Morse & Co., Magneto Division, Beloit, Wisconsin.

BUILT TO TAKE A BEATING

- Compact, rugged, self-contained unit—few working parts
- Sturdy impulse coupling of simple design for easy starting
- Alnico Super Magnets cast into powerful one-piece magnetic rotor
- Steady hot spark at all speeds
- Large, long lasting breaker points for quick starts—smooth performance
- Oversize high tension coils—built to take a beating



This is type FM-XOR six cylinder magneto with ball bearings throughout—available in base or flange mounting.

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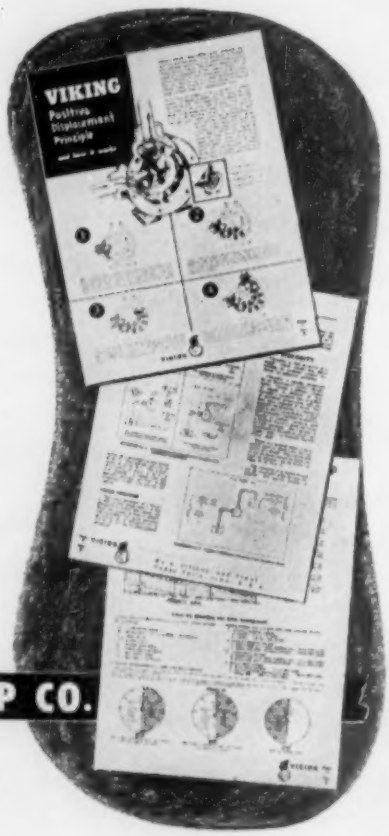
PUMPING PROBLEMS

NEW 40 page VIKING Engineering Manual

A new 3-part, 40-page engineering manual including Viking rotary pump fundamentals, the 10 steps in selecting a Viking pump, and a special engineering section will help you in choosing the right rotary pump for your job.

This manual is free upon request. Write today for Manual K1.



VIKING PUMP CO.

Cedar Falls, Iowa

See our catalog in SWEETS

nois senator is as sure a way as could be found to dry up the supply of gas available to consumers in his and other consuming states, for it virtually would eliminate all chance for a producer to make a profit on the gas he sells . . .

"The Douglas proposal, of course, is meant to counteract the effort to have the producion of gas exempted from federal regulation. As Congressman Wright of Weatherford points out in a recent news letter, if such exemption is not enacted the independent producer of gas will suffer, the economy of the Southwest will suffer, and in the long run the housewife who uses gas will suffer. The reason is that gas cannot be sold until it is found, and nobody will be interested in the expensive search for it unless he has prospects of selling it at a profit."

Editorial from the Fort Worth Star-Telegram.

CALENDAR OF EVENTS

APRIL

- 4-5 Wilcox Trend Symposium, Eighth Oil Recovery Conference, Texas Petroleum Research Committee, Texas A. & M. College, College Station, Tex.
- 5-7 Corrosion control short course, sponsored by University of Oklahoma and Central Oklahoma Section of National Association of Corrosion Engineers, University of Oklahoma Extension Study Center, Norman, Okla.
- 13-15 Rocky Mountain District, American Petroleum Institute, Division of Production, Gladstone Hotel, Casper, Wyo.
- 13-15 Natural Gasoline Association of America, annual convention, Baker and Adolphus hotels, Dallas.
- 13-15 American Society of Lubrication Engineers, tenth annual meeting, Hotel Sherman, Chicago.
- 13-15 National Petroleum Association, 52nd semiannual meeting, Cleveland Hotel Cleveland.
- 14 Independent Oil Producers and Land Owners Association, Tri-State (Illinois, Indiana, and Kentucky) annual meeting, McCurdy Hotel, Evansville, Ind.
- 18 Illinois Oil and Gas Association, 10th annual meeting, Mt. Vernon, Ill.
- 18-20 American Society of Mechanical Engineers, spring meeting, Lord Baltimore Hotel, Baltimore.
- 19-20 Pacific Coast Gas Association, distribution conference, Phoenix.
- 19-21 Oil Heat Institute of America, annual meeting, Conrad Hilton Hotel, Chicago.
- 19-21 Southwestern Gas Measurement Short Course, North Campus, University of Oklahoma, Norman, Okla.
- 19-22 Vancouver Section, National Association of Corrosion Engineers, corrosion short course, University of British Columbia campus, Vancouver.
- 20-22 Petroleum Industry Electrical Association, annual conference, Shamrock Hotel, Houston.

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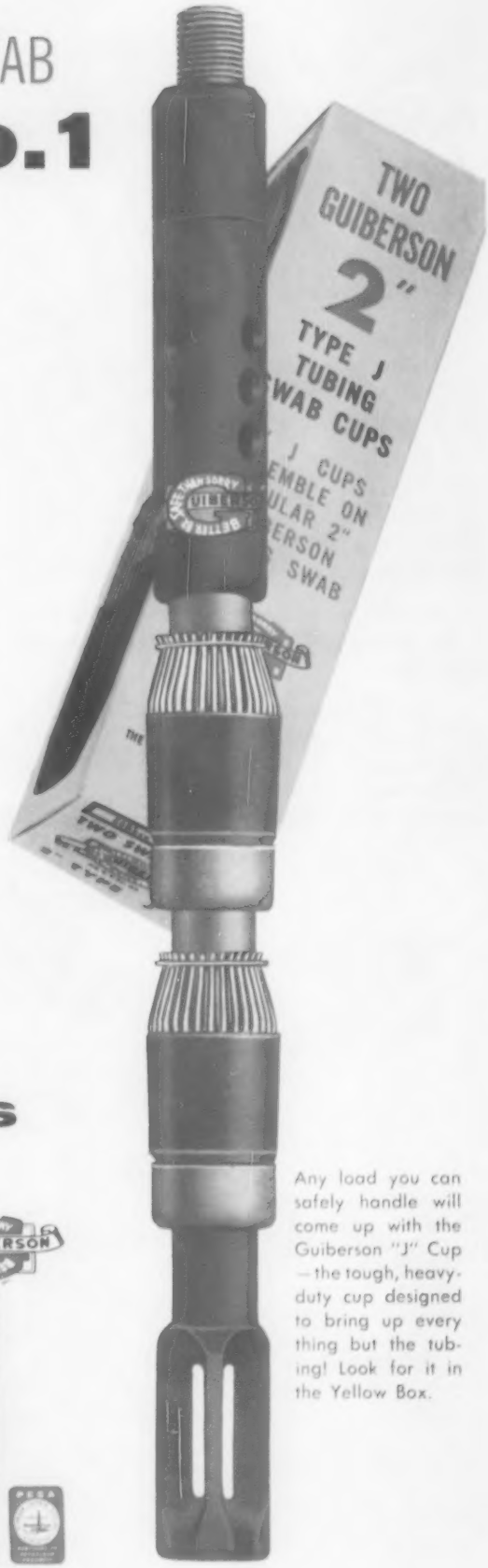
world's no.1 swab

Because it

gives you more efficiency and reliability – more for your money

Because

we manufacture our swab cups in our own rubber plant – from our own carefully compounded synthetic rubber formulas



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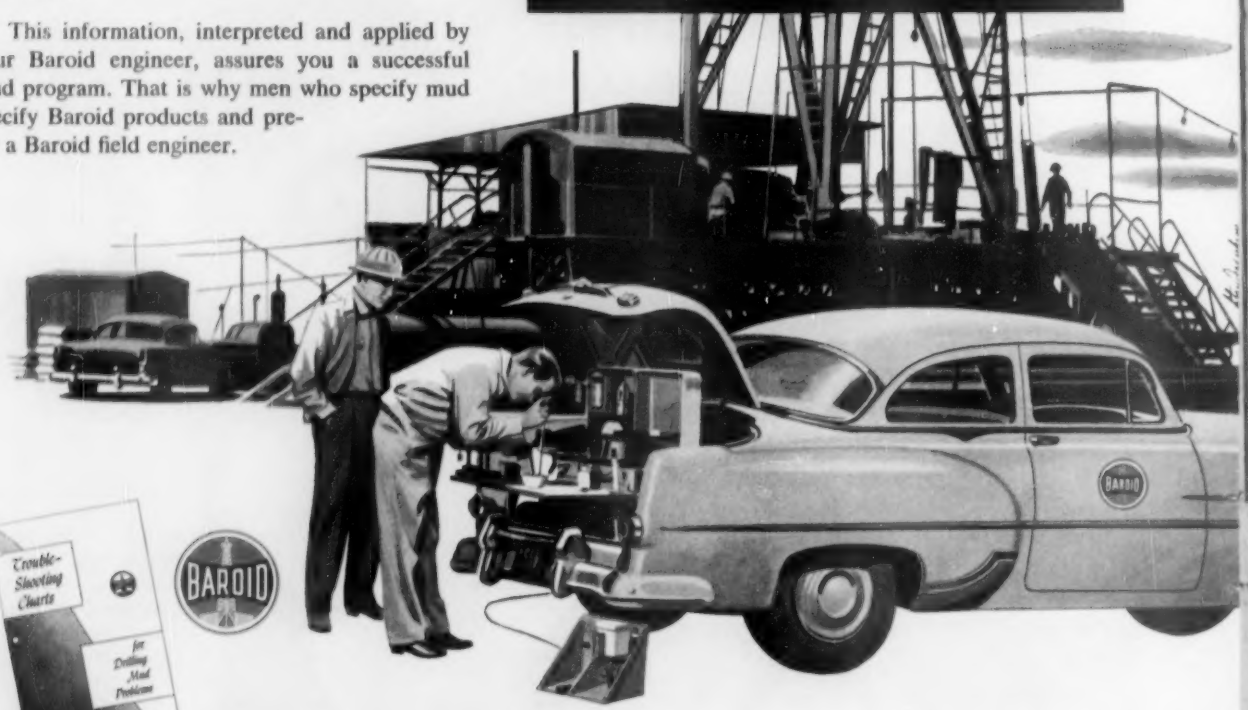

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24-27 American Society of Mechanical Engineers, Region VIII engineering conference, Rice Hotel, Houston.

25-26 Independent Petroleum Association of America, midyear meeting, San Antonio.

27 American Society for Testing Materials—DCC, Kansas regional group meeting, Lassen Hotel, Wichita, Kans.

28-29 American Petroleum Institute, Division of Production, spring meeting of Pacific Coast district, Statler Hotel, Los Angeles.

28-29 Refining Committee, Rocky Mountain Oil and Gas Association, annual meeting, Cosmopolitan Hotel, Denver.

29-30 American Association of Petroleum Landmen convention, Hilton Hotel, Fort Worth.

MAY

1-4 Liquefied Petroleum Gas Association, annual convention, Conrad Hilton Hotel, Chicago.

1-4 American Institute of Chemical Engineers, Shamrock Hotel, Houston.

2-3 Gas Compressors Institute, Legion Hall, Liberal, Kans. Sponsors: University of Kansas and Southwest Kansas Petroleum Industry.

2-6 American Gas Association, Industrial Gas School, Hotel William Penn, Pittsburgh.

9-10 American Gas Association, Gas Supply, Transmission and Storage Conference, Hotel William Penn, Pittsburgh.

9-11 10th Purdue Industrial Waste Conference, Memorial Union, Purdue University.

9-12 American Petroleum Institute, Division of Refining, midyear meeting, Jefferson Hotel, St. Louis.

11-12 Pacific Coast Gas Association, gas supply and transmission and conference of technical session, Palm Springs, Calif.

11-13 Petroleum and Natural Gas Division, Canadian Institute of Mining and Metallurgy, sixth annual convention, Edmonton, Alta., Canada.

11-13 American Petroleum Institute, Division of Production, Eastern District spring meeting, William Penn Hotel, Pittsburgh.

12-13 Sixth Symposium, "Automation—Engineering for Tomorrow," School of Engineering, Michigan State College, East Lansing, Mich.

12-19 Sixth Latin American Congress of Chemistry, Caracas, Venezuela.

14-22 World Wide Chemical Plant and Equipment Exposition and Congress, Frankfurt, Germany.

16-18 American Petroleum Institute, Division of Transportation, products pipeline confrence, Edgewater Beach Hotel, Chicago.

16-18 Southern Gas Association, New Orleans.

19-20 Society of Exploration Geophysicists, 10th annual Gulf Coast meeting, Plaza Hotel, San Antonio.

20-22 Appalachian Geological Society, Virginia Geological Survey, and West Virginia Geological Survey, spring field conference, Kavannaugh Hotel, Harrisonburg, Va.

23-25 American Petroleum Institute, Division of Marketing, midyear meeting, Chase and Park Plaza hotels, St. Louis.

26-27 Western Petroleum Refiners Association, technical-industrial relations meeting, Settles Hotel, Big Spring, Tex.

26-27 American Institute of Mining and Metallurgical Engineers, Rocky Mountain Petroleum Sessions, Shirley-Savoy Hotel, Denver.

26-27 Kentucky Oil and Gas Association,

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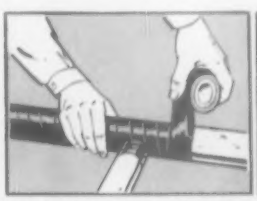

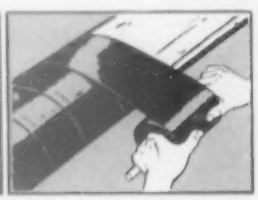

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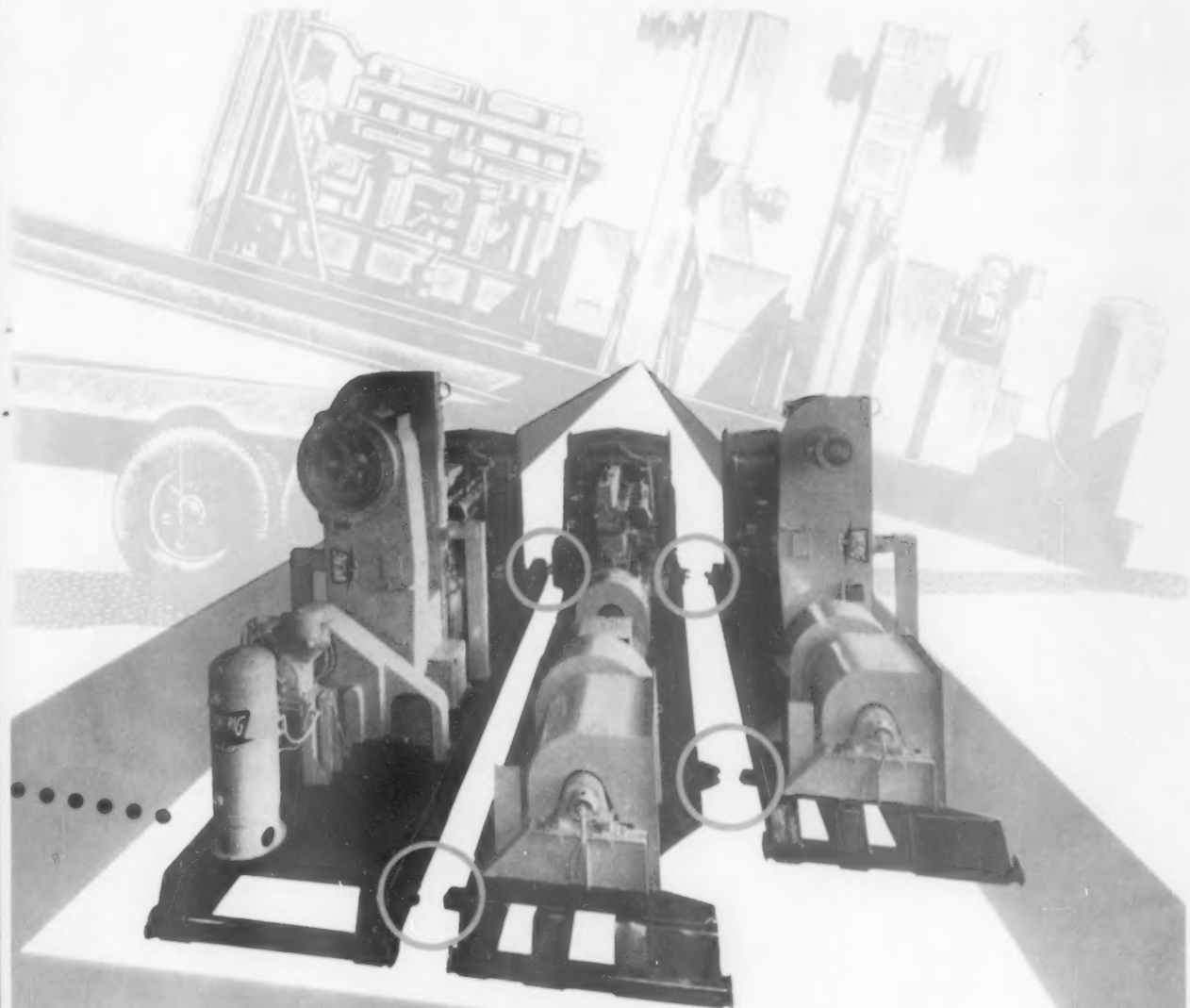

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annual meeting, Lafayette Hotel, Lexington.

30-
June 1 Chemical Institute of Canada, thirty-eighth annual conference and exhibition, Quebec City, Que.

JUNE

1-3 Tenth annual Short Course on Gas Technology, Texas College of Arts and Industries, Kingsville, Tex.

5-9 Canadian Gas Association, annual meeting, Sheraton-Broeck Hotel, Niagara Falls, Ont.

6-9 Oil and Gas Power Division, American Society of Mechanical Engineers, 27th annual conference and engineering exhibit, Hotel Statler, Washington, D. C.

6-10 American Petroleum Institute, Division of Production, midyear committee conference, Brown Palace Hotel, Denver.

6-15 Fourth World Petroleum Congress, Rome, Italy.

7-9 National Oil Scouts and Landmen's Association, 32nd annual meeting, Banff Springs Hotel, Banff, Alberta, Canada.

9-10 Natural Gas and Petroleum Association of Canada, Royal Connaught Hotel, Hamilton, Ont.

9-10 Pennsylvania Grade Crude Oil Association, annual meeting, Hotel William Penn, Pittsburgh.

11-15 Petroleum Equipment Suppliers Association, annual meeting, Banff Springs Hotel, Banff, Alberta, Canada.

12-17 Society of Automotive Engineers, golden anniversary summer meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

16-18 Interstate Oil Compact Commission, Cosmopolitan Hotel, Denver.

17 Northern California Section, American Institute of Chemical Engineers, symposium on waste disposal, University of California, Berkeley, Calif.

20-23 American Society of Mechanical Engineers, semiannual meeting, Statler Hotel, Boston.

23-24 Western Petroleum Refiners Association, technical-industrial relations meeting, Broadview Hotel, Wichita, Kans.

23-26 Rocky Mountain Oil Show, Casper, Wyo.

26-
July 1 American Society for Testing Materials, Chalfonte-Hadden Hall, Atlantic City, N. J.

AUGUST

15-17 Society of Automotive Engineers, golden anniversary West Coast meeting, Hotel Multnomah, Portland, Ore.

29-31 15th annual Appalachian Gas Measurement Short Course, West Virginia University, Morgantown, W. Va.

SEPTEMBER

11-13 Independent Natural Gas Association of America, annual meeting, Jasper Park Lodge, Jasper Park, Jasper, Alberta, Canada.

13-24 First International Instrument Congress and Exposition, and ninth National Instrument Conference and Exhibit, Philadelphia.

14-16 National Petroleum Association, 53rd annual meeting, Traymore Hotel, Atlantic City, N. J.

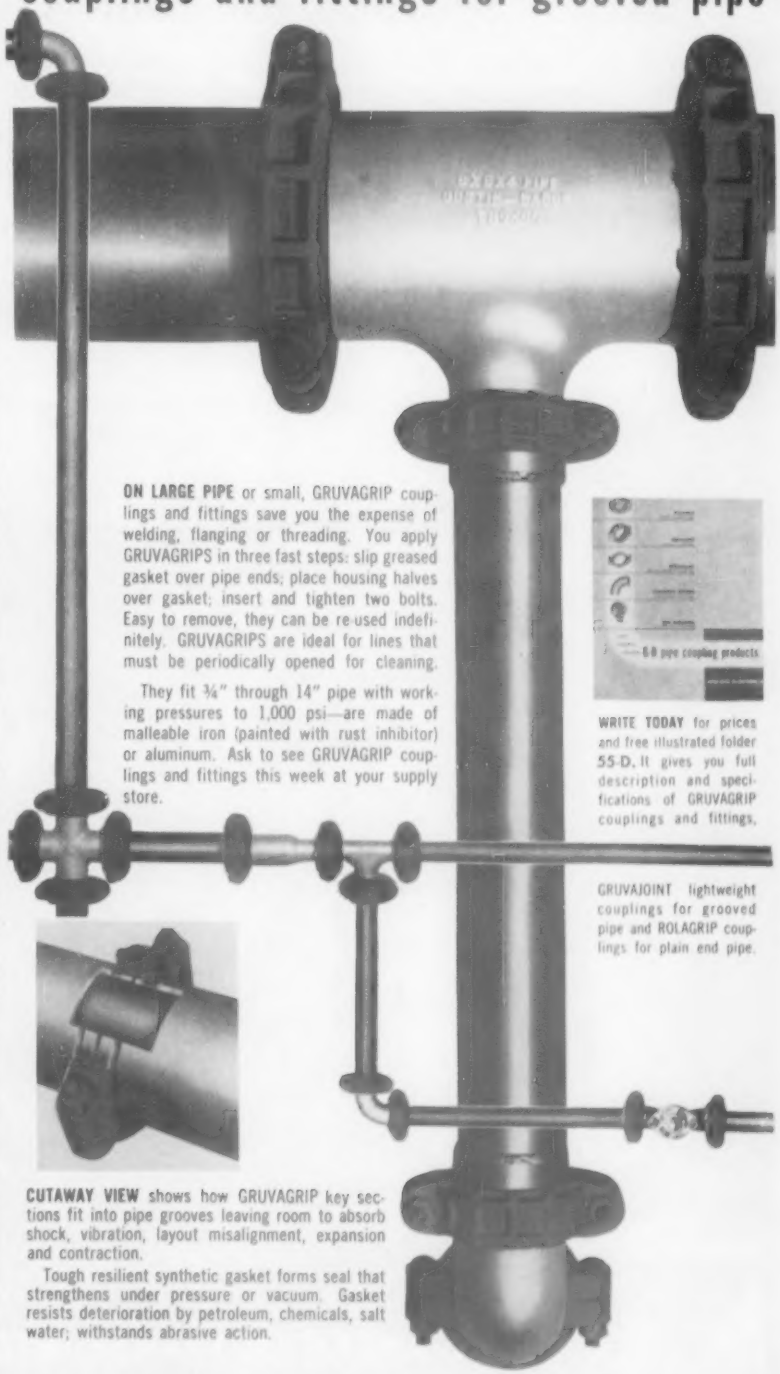
22-23 Western Petroleum Refiners Association, regional technical-industrial relations meeting, Hotel Henning, Casper, Wyo.

22-23 Louisiana-Arkansas Division, Mid-Continent Oil and Gas Association, annual membership meeting, Roosevelt Hotel, New Orleans.

26-28 American Association of Oilwell Drilling Contractors, fifteenth annual meeting, Rice Hotel, Houston.

GRUVAGRIP

couplings and fittings for grooved pipe



ON LARGE PIPE or small, GRUVAGRIP couplings and fittings save you the expense of welding, flanging or threading. You apply GRUVAGRIPS in three fast steps: slip greased gasket over pipe ends; place housing halves over gasket; insert and tighten two bolts. Easy to remove, they can be re-used indefinitely. GRUVAGRIPS are ideal for lines that must be periodically opened for cleaning.

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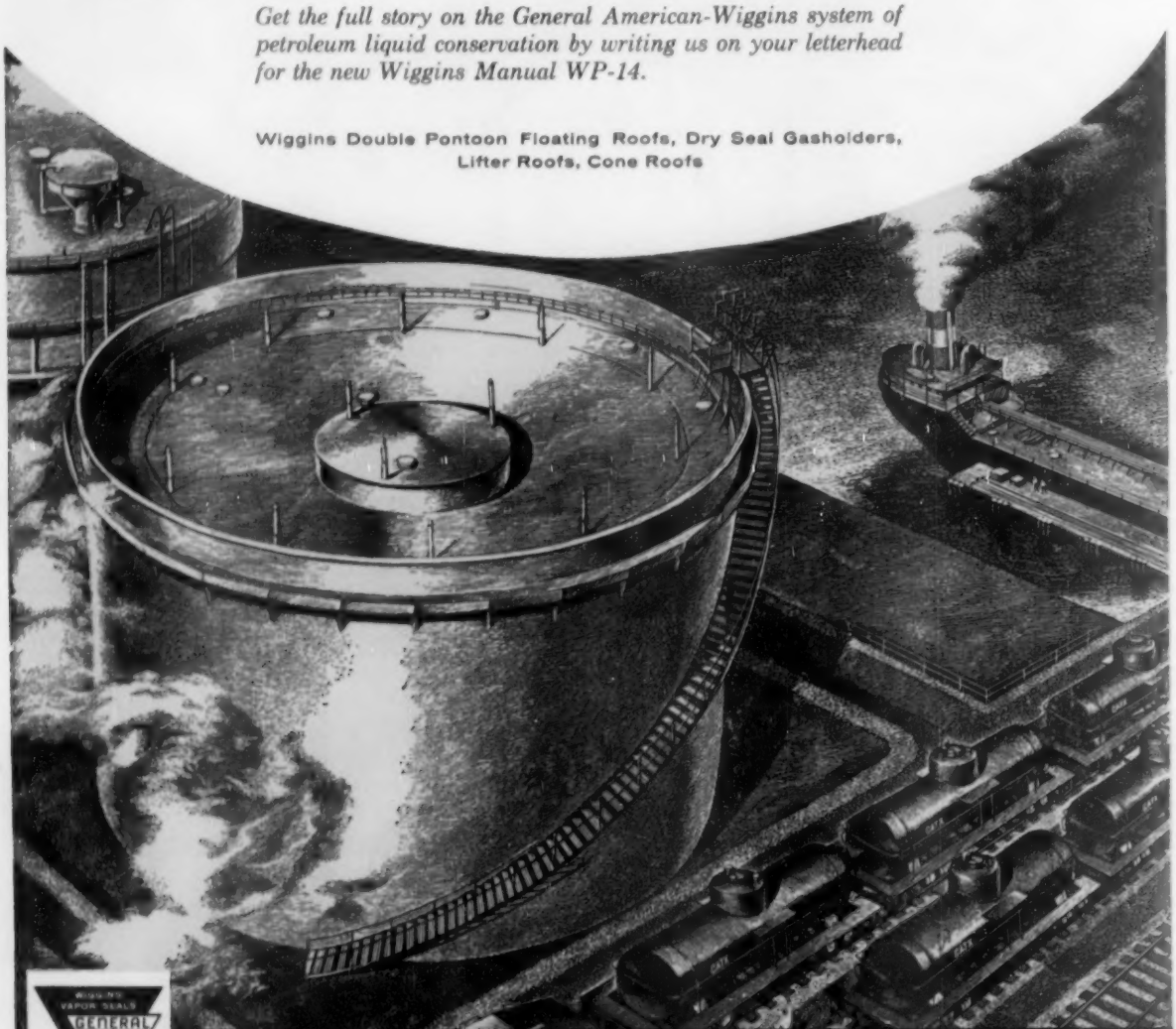

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TULSA, OKLAHOMA

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JOURNALLY SPEAKING . . .

Oil from Fog

MOST geologists are all wet. They're on the wrong track in their oil finding. The reason is that they've been following the organic theory of the origin of oil, instead of the inorganic theory.

Such is the view of one of our readers, who, in all seriousness, contributed an essay espousing the inorganic theory. We've been saving it for months especially for this week's issue.

Out of pure meanness we're running it here to offset the big special section that Dr. Frank J. Gardner and his staff assembled for this annual Exploration Issue. All their stuff is based on the organic theory, and not a word about the other side.

So we're undermining it by giving space to this disciple of inorganic geology. Nothing like openmindedness and academic freedom, you know.

His theory is that oil comes from fog—underground fog—and that it condenses just as rain is condensed from clouds.

"In the past," writes our contributor, "I have read and studied both the organic and inorganic theories relating to the origin of oil, gas, and coal, and have never been able to divorce myself from the inorganic theory.

"While the organic theory is the one most generally accepted and embodied in our textbooks on geology, that theory, I believe, is being disproved by the deep producing oil wells drilled in the United States and the relatively small quantity of high-grade oil they make.

"Those deep wells all make a higher grade oil than that found at shallower depths—in most instances; and the reason for that, I believe, is that it is newer oil than that found higher up, and suggests the conclusion that the shallower or shallowest oils found are the oldest of the oils.

"There are more than a thousand properties in oil, coal, and gas. Could these properties, and the quantity of oil, coal, and gas we have, come from the meager quantities of organic matter existing at the time of the deposition of the coal, oil, and gas?

"The inorganic theory supports the conclusion that oil is still being created and deposited at greater depths in the upper crust of the earth, and will continue to do so—not from organic matter, but as the result of ascending gas from the hot zones of the earth below the outer crust of the earth, which, ascending upward, reaches strata cold enough to condense the gas, with the result that new oil is there deposited.

"Such condensing could continue over hundreds or thousands of years where it first starts with the result that, finally, water enters the condensate deposit, drives away the lighter properties of the condensed matter, and keeps it moving until it finally becomes trapped in the structures where the oil producers find it, while the baser elements of the original condensation remain in place—unmoved by the water—and with sufficient age become coal.

"There is a similarity in the making of rain and that of oil, in that fog from our greater bodies of water ascends upward to make our rain clouds; those clouds drift until they contact a stratum or strata of air cold enough to condense the fog—and we have rain, while gas from the hotter and deeper zones of the earth ascends upward and upward—and is condensed with the results stated."

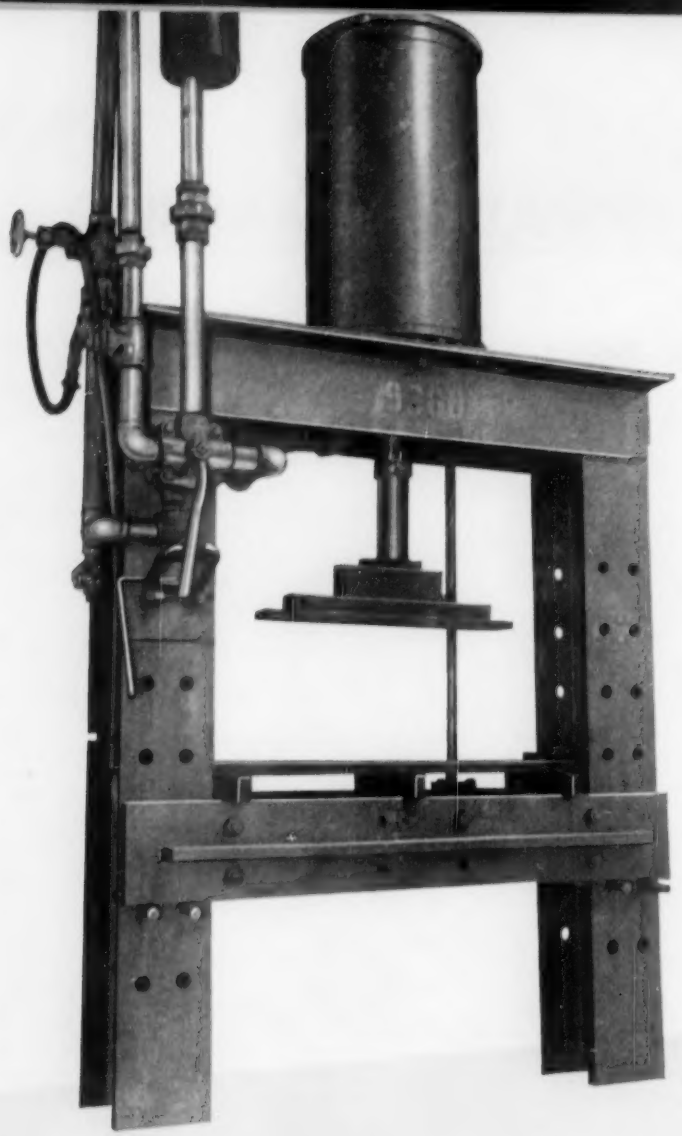
So there you have it. We'll leave it to you to decide which theory to believe. As for us, we're strictly neutral, never having studied any kind of geology.

But there is much that is appealing in the inorganic theory. It's mighty comforting to feel that we're never going to run out of oil because more is being made down in the bowels of the earth all the time.

All we have to do is drill deep enough to tap these streams of carboniferous gases ascending from the hot zones below the outer crust of the earth and cool them and wash them enough to get coal, oil, or natural gas, whichever we prefer. Just like rain, fog, and dew.

This would make it unnecessary to bother with geologists, geophysicists, paleontologists, mineralogists, doodlebuggers, and such like. Somehow we sort of like this fellow's theory.

—*Henry D. Ralph.*



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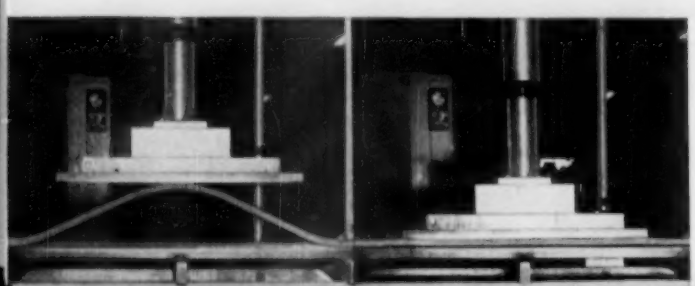

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How to fill the gap in oil finding

GEOLOGISTS and geophysicists deplore any suggestion that there is a "gap" between them. But—call it what you will—there is a degree of rivalry, or prejudice, or self-centeredness which hampers the fullest coordination of their respective skills in the difficult task of finding oil.

The existence of this situation is recognized by the exploration departments of most oil companies. It will be admitted, privately, by a good many members of both professions.

The problem is how to close this gap—and any other gaps—in our knowledge and technique of finding oil.

A "LITTLE BLACK BOX" that will tell exactly where oil lies beneath the surface has been wished for by the industry for nigh onto a century. Neither the gravimeter, the seismograph, nor the scintillometer is it. Neither is any one branch of science.

Until that mythical, magical instrument comes along, oil hunters will have to improvise a "black box" out of all the tools available.

Into the oil hunter's box should go field and subsurface geology, geophysics, mineralogy, paleontology, geochemistry, core and mud analysis, log interpretation, electronics, nuclear science—and space for anything else that promises to come in handy.

But the two most important things in the box should be coordination and imagination—coordination to apply each tool to its best use and to make them all work together; and imagination to fill in where the whole kit of tools fails to give the answer.

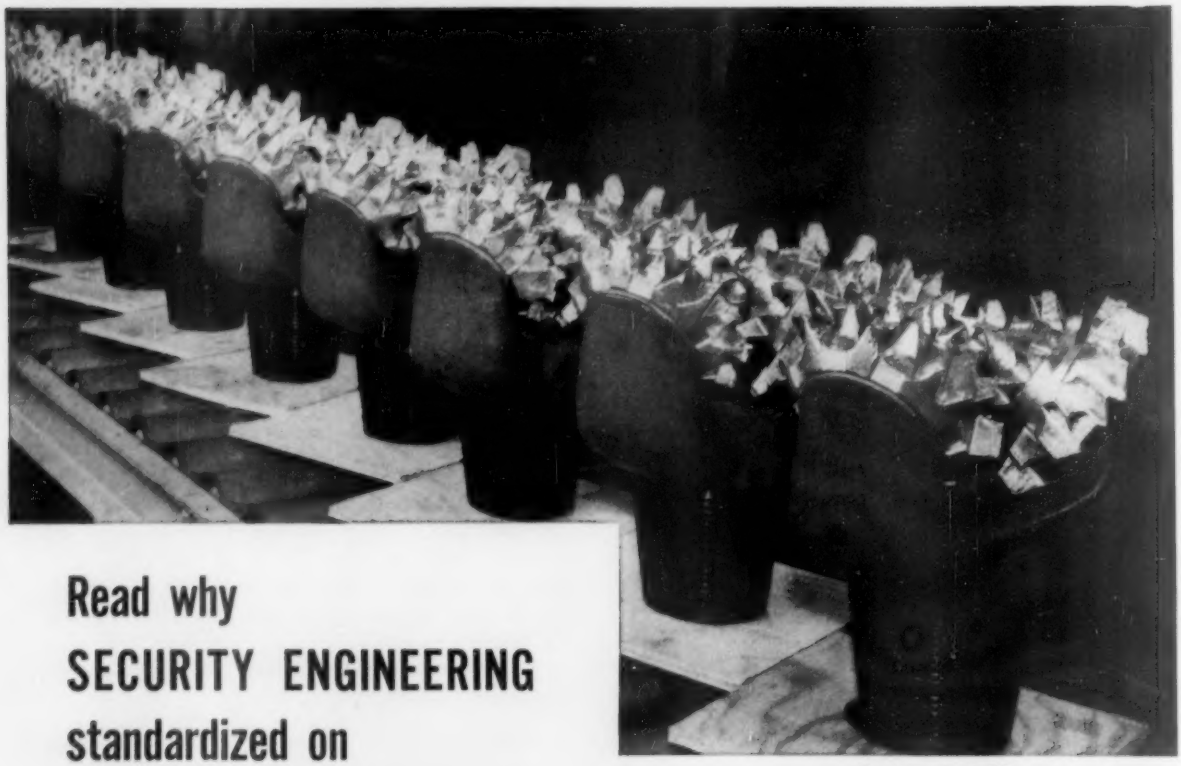
We can't advise on how to develop imagination, but coordination is something that can be achieved if it is worked at with a will.

THE FIRST ESSENTIAL is recognition that no one science or method is THE way to find oil, but that all can help. This is acknowledged in theory, but too often in practice a man trained in one specialty fails to give adequate consideration to another.

Next, the various specialists should be brought together more, to develop teamwork and crossfertilization of ideas. More regional joint meetings of scientific societies would be good.

Finally, perhaps all these skills and professions should be confederated under a general association of oil hunters. The difficulty of agreeing on a name for such illustrates the present professional jealousies, but a national society of earth studiers might bring about unity in the same way that "medicine" embraces all the healing arts.

Until physical science fills the gap in the oil finder's black box, that gap should be bridged by the human sciences of coordination and imagination.



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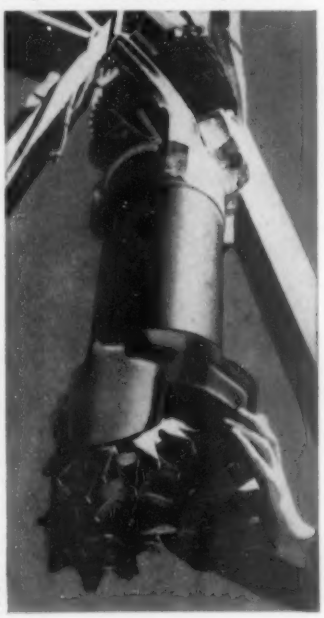

You know that rig operating costs leave no room for second chances. Drilling calls for cutters that are right the very first time they're run into a hole . . .

Accordingly, to assure the ultimate in stamina for both case and core of these vital parts, Security Engineering Division, one of the Dresser Industries, standardizes on cutters made from nickel steels.

By far the best performer reported by Security Engineering is a carburized nickel-molybdenum steel which provides unusual surface hardness . . . for wear resistance . . . backed by a tough core that withstands heavy shocks and overloads. From this carburized steel of the 4812 type, Security produces rock bit cutters in a variety of tooth patterns.

Type 4620 is another case-hardening nickel-molybdenum steel utilized by the manufacturer of these tools. This grade, also notable for its dependable mechanical properties, is specified in cutters for hole reamers, and casing scraper mandrels.

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THIS WEEK . . . . . IN THE NEWS

Exploration

• Many oil companies, especially independents, have joined the parade of uranium hunters. But in most cases, uranium exploration is just a sideline to their operations. They still would rather find an oil field than a uranium deposit.

• Geophysics will play a more important part in future oil exploration. This is the forecast of Paul L. Lyons, outgoing president of the Society of Exploration Geophysicists. New instruments, new techniques, and new ideas will aid in the comeback, Lyons predicts.

• A new oil field—second in the state—is in prospect for South Dakota. Indicated discovery is 8 miles southwest of Buffalo field, the state's only producing area.

• Nevada's first oil field, discovered in 1954, has been confirmed by Shell Oil Co. in a 1,700-ft. offset.

• Keen interest surrounds southern Oklahoma wildcat which already has set off a big lease play by uncovering a prolific shallow pool. The test, being drilled by Frankfort Oil Co., is seeking deep production after passing through a thick Viola pay zone.

International

• Major oil companies soon may renew exploration in Argentina. President Peron says the government has agreed on terms for new concessions, which would be the first granted in 21 years.

• Iraq has joined the example set by Iran in taking a bigger cut of revenue from foreign-developed oil fields. Other Middle East nations may join the trend.

• Fast-growing refining industry in India will enable country to meet most of its needs for petroleum products. Latest addition is 40,000-bbl. Burmah-Shell refinery at Bombay.

• Crude production in the Free World increased to 13,204,900 bbl. daily in January for a gain of 357,600 bbl. per day over preceding month. U. S., with output at all-time high, had biggest increase.

Refining

• Record octane production at relatively mild processing conditions claimed for new Rexforming process just announced by U.O.P. The process will enable refiners to make high-quality products economically from comparatively low-quality feed stocks.

• New high-alumina catalyst gives better results than conventional 13 per cent alumina catalysts in cat-cracker operation, refiners told. The new catalyst, 25 per cent alumina on a silica base, permits normal cat-cracker operation with less catalyst loss or increased product output at lower temperatures.

• Frontier selects Fort Pierce, Fla., site for a 15,000 bbl. refinery. Construction is to begin immediately, completed in August 1956.

Production

• Production men soon will get a look at a new well-treating process using explosive pellets to blast oil-sand fractures. Called "Stratablast" by Dowell engineers who developed it, the technique may become a major factor in boosting production.

• Stanolind is preparing to start long-awaited water-flood program in Sholem Alechem field of southern Oklahoma. The flood is expected to boost production more than 48 million barrels and extend life of pool to 1977.

• Oklahoma House of Representatives gives tentative approval to attempt to set state minimum allowables to 25 bbl. daily on lease basis.

Natural Gas

• It now appears the Harris bill, as written, will not be passed by Congress. Pipeliners want the bill changed to give equal protection to producers, transmission systems, and consumers. The House interstate commerce committee heard the gas industry story last week. It will hear next from consumer interests who do not want the FPC relieved of authority to regulate field gas prices.

• TIPRO specifically endorses the Harris bill to amend the Natural Gas Act and does so in demanding language. At the same time, TIPRO refused to back away from its support of the economic waste bill before the Texas Legislature.

Imports

• The U. S. Senate finance committee has a real problem as it begins secret sessions on extension of the Reciprocal Trade Act. The big fight will be over what to do about imports plaguing the oil, coal, and other industries. The secret sessions follow public hearings at which domestic oil producers made a fight for the Neely amendment limiting oil imports.

• TIPRO wavered momentarily in its backing of the Neely amendment, but decided it has gone too far in Congress to change. TIPRO is supporting it.

MAJOR OIL FIRMS, because of high overhead, generally aren't interested in small uranium mines like these "rat holes" in Utah.

Uranium—No Bonanza for Oil Men

- **Experts say single oil well will gross as much cash in 2 years as average uranium mine will in a lifetime**
- **Oil men not overlooking any bets; they're using tools, know-how, and gambling spirit to search for both**

THE oil industry, like many individuals, has been bitten by the uranium bug. Many companies now explore both for oil and uranium, and some enterprising geologists will taste for oil only after they have checked radioactivity of cuttings with a geiger counter

Independents have flocked to the Rocky Mountain region with a twofold goal—oil and uranium. Some majors have set up new departments to explore for uranium, and others are about to join the parade.

In most cases, though, oil companies are cool toward the uranium craze. They still would rather find a modest-sized oil field than a big uranium deposit.

The reason is simple—there's more money in oil. A medium-sized oil field is worth more than the richest uranium mine yet dug.

Even in the uranium-loded Colorado Plateau, 100,000 tons of ore is a major deposit. Average grade of ore produced in that region is about 0.25 per cent, which means a ton of ore yields about 5 lb. of uranium. Such ore sells for about $35 a ton. On this basis, a 100,000-ton deposit would gross $3,500,000.

To gross the same sum, an oil operator needs only one small field of 14 wells with a lifetime production of 100,000 bbl. each.

The chances of finding quick wealth with a geiger counter appear even more remote when the average value of a uranium mine is considered. About 750 such mines are in operation, and their average deposit is estimated at 5,000 tons of uranium ore. At $35 per ton, such a deposit is worth only $175,000.

One well producing 100 bbl. of oil per day would gross that much in 2 years.

Exploration methods . . . It's not surprising that so many oil men have one ear cocked toward the rhythmic click of a geiger counter. Probably nobody is better equipped to find uranium. Many of the instruments used in routine search for oil are equally suited to find uranium.

Gravity, magnetic, and seismic surveys may detect uranium lodes as well as potential oil-bearing structures. Core drilling and soil analysis, both common in the oil industry, also may uncover uranium ore.

"The very nature of an oil company adapts it to transfer to uranium production," commented a spokesman for a major oil company at Denver.

Although his company is only mildly affected by the epidemic of uranium fever spreading through the Rockies, he pointed out that an oil company can easily shift into uranium exploration. "You could kill two birds with one stone by applying oil-company research and oil geology to a search for uranim," he added.

There is a close relationship between prospecting for oil and uranium. Both searches concentrate on sedimentary rocks. In many cases, finding uranium is largely a problem in sedimentation. Such problems fall within the scope of the petroleum geologist rather than the hard-rock mining geologist.

Many of the techniques of oil prospecting may be applied directly to uranium work. The oil finder is skilled in tracing stream channels and marker beds, mapping with seismic techniques, following outcrops, relating surface and core-hole geology, and electric and radioactive logging. These techniques are foreign to most mining men.

The oil industry has a ready supply of geological knowledge, risk capital, and gambling spirit—three of the greatest assets in finding uranium. If it keeps one eye cocked for uranium, an oil firm may find more of the precious ore almost by accident than the average pick-and-shovel prospector will find in a lifetime of digging.

Different approach . . . Although oil and uranium hunting rely on some of the same tools, they vary greatly in other aspects.

Perhaps the greatest contrast is in the size of prospects. In exploring untested regions, oil companies look for large structures covering several square

miles. They gear their technique, and their thinking, to such a scale. In contrast, a uranium deposit will be from 300 to 1,000 ft. long and perhaps 50 to 100 ft. wide. Normal oil exploration would find such a deposit only by stumbling onto it.

But to compete with a full-time uranium prospector, an oil geologist needs only to modify his thinking. Instead of looking merely for a large oil pool, he must study geological trends in much greater detail. He must check even the "suitcase sands."

Oil's role . . . Most oil companies are participating in the uranium game merely as spectators, and some of them won't admit that much interest. A few are actively searching for uranium as well as oil. Many others are watching intently and are preparing to branch off into the uranium business if prospects look favorable enough.

So far, independent oil companies have shown more interest in uranium than have the majors. But some of the majors will dabble in it if the effort is not too costly and it it doesn't detract from their routine oil operations.

Kerr-McGee Oil Industries, Inc., one of the first to combine oil and uranium hunting on a big scale, is very active in the Four Corners area of Colorado, New Mexico, Utah, and Arizona. The firm operates a uranium - processing plant at Shiprock, N. M., and plans to establish uranium - exploration headquarters in Denver soon.

Phillips Petroleum Co. also is active in that region. The firm has been looking for uranium, in addition to oil, for 9 months. Operations are under a strategic minerals department established recently at Salt Lake City. In addition to uranium, an official said, Phillips exploration activities cover phosphates "and any other minerals which management believes should be studied."

The Texas Co. has joined with New Jersey Zinc Co. to look for uranium.

Carter Oil Co. and Shell Oil Co. are looking into the uranium situation to determine whether they should branch out into that field. Carter may set up a small section of trained personnel to digest geological data obtained in looking for oil. But, as one Carter official observed, "You don't switch goals overnight."

Atlantic Refining Co. has equipped seismograph parties in the Rocky Mountain area with geiger counters.

In Texas, quite a few independents have gone into the uranium business as a sideline. Curry, Shields & Curry, of Dallas, for instance, has joined with some former Atomic Energy Commission men and others to create a company called Thunderbird Minerals. This firm is exploring the Four Corners area and other sections of the Rockies. Byrd Oil Co. also has set up a subsidiary to look for uranium on oil and gas leases.

HELICOPTERS often are used in exploring for uranium, especially in rough terrain. This Bell helicopter is equipped with a scintillometer in the cabin, and on its landing gear it carries a portable diamond core drill, which is assembled beside the plane.

Sabre Uranium followed a reverse pattern. It found some uranium, then branched off into the oil business.

Many other oil firms, large and small, are interested in uranium to some degree. But rumors usually exaggerate their interest. One report, for example, claimed that Hunt Oil Co. had purchased 25 squadrons of seven airplanes each to be used solely in looking for uranium. Each plane reportedly carried $5,000 worth of detecting instruments to explore practically the entire United States and perhaps much of Canada. Investigation revealed Hunt has two airplanes equipped with scintillometers. The planes are used about 10 per cent of the time in searching for uranium.

Wm. Ross Cabeen & Associates has one airplane "flying all the time" over an area from Arizona to North Dakota. It has a geologist-pilot prospecting for uranium from the air. A major part of its current work is done for persons interested in both uranium and oil.

Government control . . . Federal control of the uranium market has made many oil operators hesitant. The price is pegged by the Government until 1962. After that, a price drop could wipe out what now looks like a fortune in the making.

Another problem, although a distant one, is the threat that uranium processors may be declared public utilities and their profits fixed by the Government. Some oil men expect the danger of federal control to increase as uranium gains importance as a source of industrial power.

Since uranium operations are so closely tied to the Government, they are highly vulnerable to political attack. Already the Government's role is making it hard for geophysical companies to gain a foothold in uranium. The Defense Minerals Exploration Administration will not only lend money to help little operators get started, but it will log exploratory holes for them.

Future . . . Uranium seems destined to become an important industry. As atomic power is converted to industrial use, more and more oil companies may join the search for raw material to power the atomic age.

But the atom is not pushing oil out of the industrial picture. There is little competition between uranium and oil, since both will be needed as future sources of power. Better exploratory methods will be needed if uranium is to become a prime source of industrial power, and oil companies can contribute much toward making the search for uranium more successful.

Oil companies are not ready to abandon their field for a bigger gamble in uranium. The odds are against them. While there has been no major uranium discovery in this country during the past 2 years, big oil fields are still being found.

Because of the get-rich-quick tales drifting out of the uranium country, stockholders are putting the pressure on oil companies to join the uranium rush. Management in many cases is resisting the pressure.

As one official pointed out, there are other fields more closely related to the oil industry in which an oil company might employ its talent and equipment. "We think probably that tobacco and sugar are profitable enterprises too," he said, "but we're not equipped to get into those businesses."

REXFORMING MODEL gets an inspection by David W. Harris, left, U.O.P. president, and C. G. Gerhold, his assistant and technical adviser. In the background are the three heaters and reactors, which use regular Platformer catalyst. The towers in the foreground are the pre-fractionator, stabilizer, absorber, and stripper.

Cracking The Octane Barrier . . .

. . . with U.O.P.'s Rexforming process. It will convert high-paraffin naphthas to 100-plus-octane clear gasoline

George Weber

SAN ANTONIO. — Refiners at the 43rd annual meeting of Western Petroleum Refiners Association last week heard about a new departure in making high-octane gasoline. The process is Rexforming, developed and licensed by Universal Oil Products Co.

With gasoline octanes climbing monthly, this announcement rated highest interest in the three technical sessions. *(For the full paper see page 233.)* Rexforming, said H. W. Grote of U.O.P., combines two well-established refining techniques. It is based on the conventional Platforming process which has been widely adopted here and abroad. But it goes a step further.

What Rexforming does . . . Reformate from the Platformer is charged to a solvent-extraction unit where a low-octane fraction is separated from a high-octane fraction. In normal, single-pass catalytic reforming, this unconverted low-octane fraction of heavy paraffins depresses the quality of the total reformate. In Rexforming, it is returned to the Platformer where it is converted largely to aromatics. This permits record octane production at relatively mild processing conditions. Hence a good yield relationship.

The glycol solvent used in the extraction unit is similar to that used in the Udex process. It is designed to be less selective, however, absorbing not only most of the aromatics, but also the lower-boiling paraffins which show good octane. This makes it ideally suited to this operation.

Refiners showed much interest in the fact that this new technique frees them from restrictions on catalytic reforming feed characteristics. They can operate for any octane level, even when charging naphthas of very low naphthenic and aromatic contents. This means high-quality product can be made economically from such paraffinic feeds as natural gasoline and cycle distillate. It also improves the processing characteristics of naphthas from certain crudes, such as those from the Middle East.

Platformer conversion . . . While it is probable that a number of Rexforming units will be licensed in the near future, it is also likely that many existing Platformers will be converted to the new type of operation. This can readily be done, said U.O.P. Some additional heat input capacity will be necessary in the feed preheater. This can be added without replacing existing furnaces. Some additional stabilizer capacity will also be necessary.

But U.O.P. stressed that no additional catalyst is necessary in such a conversion. Higher space velocities at the milder operating conditions will permit the use of the reaction section of a conventional Platformer, as is.

Refiners with Platformer-Udex units can also convert their Udex units to the new operation with minor modifications, if they wish. Further flexibility is offered to companies considering addition of catalytic reforming capacity. Some refiners are now starting on their second round of reformer construction.

These prospective users can build the additional furnace and stabilizer capacity into their Platformers which will make for easy conversion of Rexforming as octane levels dictate this next step. Also, it is likely that many refiners now operating Platformers, will add enough capacity in their "second round" reformer building program to permit conversion of the entire operation to Rexforming.

Costs . . . U.O.P. representatives say operating costs for Rexforming will run ¼ to ½ cent per gallon higher than for Platforming. Investment costs will vary with the size of the unit. The high octane product from Rexforming shows good blending characteristics when added to cat cracked stock and other motor fuel components.

Recycle rates in Rexforming will vary with the type of charge stocks, over the general range of 20 to 40 per cent of fresh feed. Addition of the high-paraffin recycle stock to feed reduces the aromatic concentrations in the total reactor feed. This promotes the dehydrocyclization of these paraffins, and the result is a high conversion to aromatics on the second pass.

Combination Unit Operating

WESTVILLE, N. J.—The Texas Co. has started operating a 12,000-bbl. per day Unifining-Platforming unit at the Eagle Point Works here.

Straightrun naphtha in the 200°-400° F. boiling range is being charged to the Unifiner, which uses byproduct Platformer hydrogen to desulfurize and otherwise pretreat the reformer feed. The Platformer is designed to produce a 90 F-1 clear octane blending stock.

Better results possible with . . .

. . . High-Alumina Catalyst

F. Lawrence Resen

SAN ANTONIO.—High-alumina catalyst—25 per cent alumina on a silica base— will stay active longer than those in use today.

A refiner using 25 per cent alumina can maintain his fluid cat cracker output with less catalyst loss, or he can increase his product output and improve selectivity by operating at lower temperatures.

At the higher output product yield is the same as with the common 13 per cent alumina catalyst, B. H. Loper, American Cyanamid Co., told refiners at the W.P.R.A. meeting here.

Loper said stack losses are lower with high-alumina. The operator of one commercial unit reduced catalyst usage from 2 tons per day to 1½ tons by switching to the 25 per cent alumina catalyst. In another unit, stack losses dropped from 3½ tons to 1½ tons per day when the high-alumina was used. This loss gradually increased to 2.7 tons per day at the end of the test run. However, when the unit was recharged with the regular catalyst, the loss rate jumped to 4½ tons per day.

Development of a commercial 25 per cent alumina catalyst is a joint operation of Shell Development Co. and Cyanamid, Loper said. The high-alumina catalyst is being used on 12 fluid catalytic cracking units with a combined feed rate of 188,000 bbl. daily.

Most of these units started using the new catalyst near the end of the year and it is too early, Loper said, to tell if selectivity or yields have changed. The relationship between catalyst usage and activity has shown definite improvement since the catalyst was changed. Some operators have taken advantage of its high activity to increase unit equilibrium activity at the same rate of catalyst use. Others have kept activity constant and cut the use of catalyst.

Comparison of the high alumina and the 13 per cent alumina catalysts was made in both laboratory and pilot-plant tests. Here are some of the results:

. . . **Activity**—From the start, high-alumina was 16 per cent more active per unit of surface area than low alumina. After 480 hours this higher activity increased to 21 per cent. The test included cyclic action, reaction, steam stripping, and regeneration.

. . . **Stability** — After 350 hours of steaming, high-alumina catalyst showed a 13 per cent greater activity than the low-alumina.

. . . **Product distribution** — Cracking high-nitrogen gas oil, product distribution remained the same with both catalyst at equilibrium. Loper noted, however, that because of the normally higher equilibrium activity of 25 per cent alumina, more gasoline and C_4's are obtained than with 13 per cent alumina. This holds true even at less cracking severity and lower reactor temperature.

If the cracking severity and reactor temperature are maintained, the conversion ratio increases and with it gasoline octane, Loper said.

. . . **Aging**—Pilot-plant tests of a full range gas-oil, showed the high-alumina catalyst produces less dry gas and carbon and more gasoline. The total gasoline-to-carbon ratio was more favorable, particularly at the same conversion rate.

After 775 cycles, the high alumina had 18 per cent less drop in conversion.

. . . **Commercial runs** — Data from various commercial runs show the same high activity as in the pilot studies, plus low catalyst loss. Regeneration temperatures (1,095°-1,115° F.) did not seem to affect catalyst stability. Stripping was equally effective with both catalysts.

Benzene demand due to rise, but . . .

. . . Refiners Won't Boost Output

NEW YORK. — National consumption of benzene this year will increase more than 8 per cent with coke-oven producers jumping their output to meet the need and petroleum operators holding the line.

The over-all use picture, given by Business and Defense Services Administration, reversed the 9 per cent decline registerd last year.

Supply will keep pace with consumption. Latest figures revealed annual rated capacity for producing benzene increased last year from 350.5 million gallons in early 1954 to 361.6 million gallons on January 1, 1955.

Current capacity included 196.2 million gallons operated by coke-oven producers, 125.4 million gallons by petroleum companies, and 40 million gallons by tar distillers. This corresponded roughly to 1954 production from these sources.

Preliminary figures (see table) on 1954 production of basic aromatics, which include benzene, showed the oil industry continuing its growth in this field *(The Oil and Gas Journal, February 28, page 74)*.

Petroleum operators last year increased their share in benzene output to 34 per cent of the total at the expense of coke-oven operators and tar distillers. The latter, however, are expected to make a comeback this year.

Other interesting facts disclosed by the BDSA report:

. . . **Toluene** from petroleum was off last year, but percentage produced in refineries rose slightly in view of further reductions by other producers.

. . . **More xylenes** came from petroleum refineries as new facilities were installed for their recovery and separation.

. . . **Petroleum industry** increased participation in total aromatics output to about 60 per cent. It is doubtful this percentage will rise much more in the next few years. Refiners are finding the octane requirements for gasoline demanding more and more of the aromatics and their interest in making chemicals is waning slightly.

Meanwhile, the American Coke and Coal Chemicals Institute issued these estimates on consumption for this year:

Styrene, 98 million gallons; phenol, 56 million; synthetic detergents, 24 million; aniline, 13.5 million; monochlorobenzene and dichlorobenzene, 9.5 million; DDT, 8.5 million; maleic anhydride, 6 million; benzene hexachloride, 5 million; exports, 2 million; and miscellaneous, 40.5 million.

PRODUCTION OF BASIC AROMATIC CHEMICALS

(Million gallons per year)

	*1954	1953	1952	1951
Benzene:				
Petroleum	83	63	36	33
Total	242	273	252	266
Per cent petroleum	34	23	14	12
Toluene:				
Petroleum	110	116	64	56
Total	143	156	105	101
Per cent petroleum	77	74	61	55
Xylenes:				
Petroleum	†108	103	62	64
Total	†117	114	72	76
Per cent petroleum	92	91	85	84
Total B-T-X:				
Petroleum	301	281	161	153
Total	502	543	429	443
Per cent petroleum	60	52	37	34

*Preliminary figures. †Estimated breakdown.

Small Refiners Hard Pressed

W.P.R.A. president sounds warning on production, imports, refinery runs; calls for real restraint, not lip service

SAN ANTONIO.—Today is the day for refiners to put their house in order, Roland V. Rodman, told the Western Petroleum Refiners Association here last week in his president's address.

The president of Anderson-Prichard Oil Corp. warned that the refining industry must remain competitive, and that price relationships between products must be dictated both by demand and economics.

Rodman pointed to the trend between 1947 and 1953, which showed an average annual domestic demand increase of 5¾ per cent. During the next 7 years, he said, the average annual gain is estimated at 3⅝ per cent.

"Purely from the standpoint of growth," Rodman said, "the outlook of the industry is bright, but we must not be unmindful of adverse specters upon the horizon. The over-all industry can only live as profits exist. These profits must have wide distribution. Today the refiners of the country are operating on two types of crude oil, one . . . domestically produced, transported and processed; the other . . . produced in foreign lands and having a laid-down cost to American refiners substantially under the cost of domestic crude."

Rodman said before World War II about 15 per cent of the crude processed by East Coast refineries was foreign oil. Last year, he said, this had reached 57 per cent.

"Several of the international companies derive from 50 to 75 per cent of their total income from foreign operations," Rodman continued. "With this I have no quarrel, except as it affects the domestic companies."

He warned that too much of the oil industry's total income is in too few hands and predicted that governmental regulation looms unless the trend in this direction is reversed.

Restraint urged . . . Rodman said forecasts for this year "indicate a plausible domestic demand of 8,500,000 bbl. of products a day"—almost 900,000 bbl. daily below the January-February average.

He warned that the over-all supply should be reduced 690,000 bbl. daily in April because of a drop in demand between March and April. He said it would be necessary for demand to increase 9 per cent over 1954 to absorb the indicated 340,000 bbl. daily increase in new supplies of oil for the remainder of the year.

"It is clear," Rodman said, "that restraint in production, importing, and refining must be exercised by the industry. This restraint must be real rather than lip service.

"A year ago we saw the same signals, but paid no attention. Many of our largest companies announced substantial cutbacks both in imports and throughputs, but their annual operating statements are now available, and almost without exception, point with pride to . . . actual increases . . ."

Rodman said the reductions must come from the "larger segments" of the industry. He said the smaller refiners do not greatly influence over-all production or throughputs and added they "are now operating either at a loss or on margins so small that an increase in cost due to a reduction of throughput might spell their destruction."

"Already various aspects of the oil industry are being subjected to congressional agitation," Rodman warned. "This is not the time for us to be divided or to lose members of our group. Self preservation demands a sound solution for our problems."

"The decision in the Phillips gas case and the necessity of remedial legislation . . . demonstrate the need of a united front."

New officers . . . Reid Brazell, president and general manager of Leonard Refineries, Inc., was elected president of W.P.R.A. to succeed Rodman. Other new officers were the following vice presidents: Bruce K. Brown, Pan Am Southern Corp., New Orleans; Harry J. Kennedy, Continental Oil Co., Houston; F. L. Martin, Suntide Refining Co., Corpus Christi; and J. W. Vaiden, Skelly Oil Co., Tulsa.

Don't Miss the Oil and Gas Field Classifier

How well do you know your oil fields?

The Oil and Gas Journal in this issue is providing its readers with a simple chart describing with drawings and text all the important types of oil structures. It is printed as a 17 by 22-in. multicolored insert map.

During the early days of oil finding, the anticlinal theory dominated thinking of geologists hunting for underground crude. Today the geologist thinks in terms of traps, faults, salt structures or any combination of conditions where oil may occur.

All these idealized structures are clearly and briefly outlined by cross-sections and maps, including both structural and stratigraphic type fields.

Banquet-Table Drilling at Wichita Falls

Top brass of North Texas Oil and Gas Association and leaders of other oil organizations gathered at speakers' table during N.T.O.G.A. directors' luncheon March 26. Left to right are George Anderson, N.T.O.G.A. executive vice president; Ralph O. Harvey, Jr., second vice president; Harry W. Bass, president, Texas Mid-Continent Oil and Gas Association; William J. Murray, Jr., chairman, Texas Railroad Commission; D. C. Norwood, N.T.O.G.A. president; William Vaughey, president, Independent Petroleum Association of America; Frank Ikard, U. S. congressman from Wichita Falls; and Wayne O. Watts, N.T.O.G.A. first vice president

S.E.G. president says . . .

Geophysics To Stage Comeback

Frank J. Gardner

NEW YORK.—Geophysics will find its place in the changing world and will stage a comeback by switching its sights and its methods.

This was the optimistic outlook expressed last week by a leader of an admittedly declining industry. But, it won't be declining long, Paul L. Lyons told the joint annual meeting of the American Association of Petroleum Geologists, Society of Exploration Geophysicists, and Society of Economic Paleontologists and Mineralogists.

Lyons, outgoing president of S.E.G., made his prediction to 3,000 delegates of the three professional societies here last week. He said 1955's continued decline in exploration indicates "we have passed the upper limit of action . . . of exploration practices as they have existed."

Lyons cited a world-wide decline from a peak of 1,040 seismograph crews in 1952 to only 840 in 1954, and almost in the same breath predicted that the world's oil reserves will either "slow their rate of increase or actually decline slightly."

Both seismograph and gravimeter have passed the crest of activity in the United States and seem inexorably committed to a long slow decline. However, no direct method of finding oil has been found to replace either.

"At the same time, a very potent nemesis or successor to petroleum itself has appeared—energy from uranium. Already to some extent our old oil-finding instruments have given way to the geiger counter and the scintillometer. Like death itself, the ultimate decline of our complex and wonderful oil industry is already distinctly in view.

"Any discussion of the future of geophysics as we know it must contemplate . . . partial replacement of oil and gas as energy sources and the ultimate role of geophysics in finding atomic energy ores," Lyons said.

What has happened . . . Lyons detailed some of the ailments of the geophysical industry, analyzed some of the causes, and then cited some cures.

He pointed out that about $325 million was spent on geophysics in the world last year, but added that "these are trying times for many geophysicists" because of the decline in the use of geophysical parties, especially in the U.S. Here are some of the elements involved in the decline:

. . . Lack of obvious, easily found structures that encouraged wildcatters to plunge in and be the "firstest with the mostest."

. . . Disappearance of open, inviting frontiers of oil exploration has discourged the oldtime wildcatter.

. . . Applications of geophysics which resulted in its rapid rise were the attempts of exploring companies to stay in the vanguard, to push forward rapidly into the geological vacuums, to skim the cream, to find first the large fruitful structures that responded easily to geophysical measurement.

. . . Some discouragement in the oil industry because it has been more difficult to use conventional interpretation techniques and find small seismic closures in picked over areas.

The point of diminishing returns has been reached, Lyons said.

"The fact simply is, for some operators, geophysical work no longer pays for itself in cold, hard cash."

Some of the answers . . . "The geophysical industry will react to this challenge," Lyons said, "for it is really a virile, new industry, and there will be another cycle of growth superimposed on the old growth curve."

He said the reasons are apparent and "the pattern for the future is evident." Here are his reasons:

. . . Millions of dollars are now invested in geophysical equipment.

. . . New techniques make it possible to get seismograph results practically anywhere on earth where it is feasible to prospect for oil.

. . . Unlimited frontiers available even for the late arrivals on the scene —the Anadarko basin and the Texas Panhandle, as examples.

. . . New frontiers in what might be called microstructures. Closures of 10 and 20 ft. are significant and worthy of drilling in some areas.

. . . Stratigraphic traps which might be the sole target of exploratory effort in the later production history of an area. Here is a tremendous exploration vacuum into which the seismograph should step.

Lyons said advanced instruments, new techniques of exploration and interpretation, and new ideas are in the future.

"The most important of these are ideas. The frontiers of those who play 'the firstest with the mostest' are limited now, but the frontiers of those who arrive however late, prepared with the 'bestest dope and the bestest ideas' are still unlimited."

NEW OFFICERS OF THE A.A.P.G. are shown here in New York with the outgoing president during the association's annual meeting. Left to right are W. A. Waldschmidt, Midland consultant, new secretary-treasurer; Edward Koester, Wichita consultant, outgoing president; G. M. Knebel, Standard Oil Co. (N. J.), New York, new president; Horace D. Thomas, University of Wyoming, new vice president; and W. C. Krumbein, Northwestern University, incoming editor.

Offshore Interest Studied

WASHINGTON.—Oil and gas operators believe there may be valuable deposits under another 595,000 acres of the outer Continental Shelf off the Texas-Louisiana coast.

They indicated last week they would bid on leases on that acreage if the Interior Department holds another sale. Department officials now are deciding whether to put more leases on the auction block.

The acreage nominated last week is only half as much as the industry said it was interested in last year when the first sales of leases were arranged. Those sales resulted in leasing of 461,870 acres.

New Frac Has a Blast

Dowell develops well-treating process which uses pellet explosive instead of sand; oil-sand fractures are blasted

TULSA.—A new well-treating technique which combines fracturing and shooting has been developed by Dowell Incorporated.

Know as "Stratablast," the experimental method is similar to Sandfrac treatment used in many fields to increase oil output. But it goes one step further. Instead of sand, explosive pellets are forced into the productive zone, then detonated.

The explosion shatters the producing zone and creates tributary fractures which expose great areas in the oil-bearing sand. By multiplying the number of flow channels through which fluids can enter a well, the new treatment may become a major factor in boosting production.

Dr. W. W. Love, director of research, said Dowell has been working on the process about 18 months. So far, Stratablast has been tested in more than a dozen oil wells in eastern Oklahoma, eastern Kansas, and North Texas. Depths of the test wells ranged from 1,150 to 4,800 ft.

Significance . . . Results of the tests have not been revealed, but Dowell appears confident that the method will prove practical.

"As soon as the development work is completed," the company announced, "the service will be released to Dowell field engineers for use throughout the oil-producing areas of the United States and Canada."

Dowell claims this is the first time solid explosives have been used in this manner. Tests have proved, Dowell announced, that a large enough concentration of the solid explosive can be forced into an oil-bearing structure "to create an efficient explosion." Type of explosive used was not announced.

The formation, when shattered by the explosion, forms its own props to hold open the fractures, the company explained. Much larger pieces of propping material are formed in the process than could be injected into the well in normal fracture treatment.

Dowell described its explosive as "safer than a handful of matches" before it is injected into a well. It can be detonated with safety to produce a "terrific" force in the producing formation. Patents on the process are pending.

Testing of the Stratablast treatment is being conducted by Dowell engineers Harold Staadt and Parke Muir, under supervision of Dana Hefley, development manager.

OIL SHOT 150 ft. into the air when this Okmulgee County, Oklahoma, well was "Stratablasted." Explosion was in producing sand at depth of 1,150 ft.

Gas System to Expand

WASHINGTON.—Capacity of the Panhandle Eastern Pipe Line Co. system will be increased 250,000 M.c.f. daily as soon as the Federal Power Commission approves.

The company told the FPC last week the project will cost about $22,400,000. It recently increased its capacity by more than 100,000 M.c.f. daily with the building of a $22,000,000 third main transmission line. The new expansion will give Panhandle Eastern a peak gas delivery rate of 1,350,000 M.c.f. daily.

Panhandle's subsidiary, Trunkline Gas Co., will provide 80,000 M.c.f. of the new gas. The rest will come from an underground storage field near Waverly, Ill.

Trunkline will spend $18,700,000 to expand its facilities. Panhandle will spend $3,714,000 for new compressor engines at three Indiana pumping stations.

Florida Refinery

Denver firm plans 15,000-bbl. Fort Pierce plant

DENVER.—Frontier Refining Co., of Denver, plans to begin construction work immediately on a new $16 million oil refinery near Fort Pierce, Fla. The 15,000-bbl. plant will be ready for production by August 1956.

Frontier President M. H. (Bud) Robineau said the project was originally planned for West Palm Beach, but public objections ruled out location there. Sites at Port Everglades and Jacksonville also were bypassed for "several economic and political reasons," Robineau said.

The bulk of the refinery's crude oil will be supplied from Mexico by Sharmex Oil Co. under a contract with the Government of Mexico. Additional crude supplies will be shipped in from Venezuela and the Far East as needed, Robineau said. The Fort Pierce harbor will be dredged to a depth of 35 ft. to accommodate deep-sea tankers.

Ebasco Services of New York, engineers for the construction project, said more than $750,000 will be spent to keep the refinery free from odors and water pollution.

Harry Brown, vice president in charge of manufacturing at Frontier and superintendent of the firm's 10,000-bbl. refinery at Cheyenne, Wyo., will supervise construction of the Florida refinery.

The refinery products generally will be marketed in Florida and along the eastern seaboard. Deliveries will be made by overland truck transport, inland waterway barges, and tenders.

Refining Processes Studied

NEW YORK.—Several refiners planning to install catalytic reforming units are taking a long look at available processes before deciding which ones to use.

Cosden Petroleum Corp. will add a second unit at Big Spring, Tex., to process 3,200 bbl. per day. Leonard Refineries, Inc., soon will announce plans for a 3,600-bbl. unit for the Alma, Mich., refinery. Texas City Refining, Inc., will add a 6,000-bbl. unit. Vickers Petroleum Co., Inc., is considering not only catalytic reforming, but more polymerization and asphalt capacity and a coking unit as well for its Potwin, Kans., plant.

Trans-Mountain Lost in '54

CALGARY. — Trans-Mountain Oil Pipeline Co., the only pipeline crossing the Canadian Rockies, showed a net loss of $2,379,453 for 1954, according to the company's annual report.

Total income was $6,841,299 and expenses $5,976,062, for a net of $865,237. Depreciation accounted for the loss.

The 750-mile pipeline during the year delivered 14,522,087 bbl. of Alberta oil for an average daily rate of 39,787 bbl.

Deliveries increased substantially during the last 2 months of the year, however, as new refineries were completed in British Columbia and Washington.

Average throughput for the first quarter of 1955 was 70,000 bbl. a day.

Nevada Has Second Well

LOS ANGELES.—Nevada's second oil well, a confirmation to the Eagle Springs' 1954 discovery, swabbed 600 bbl. of fluid per day, including 580 bbl. of oil.

The new well, Shell Oil Co. 35-35 Unit, is in the Eagle Springs unit, Nye County, 1,700 ft. from the discovery which got production from volcanic rocks. The pay of the second well is reported to be lime and sandstone.

Alaskan Leases Sold

SAN FRANCISCO. — General Petroleum Corp. has been assigned 38,400 acres of federal oil and gas leases in the southern Kenai Peninsula area of Alaska by a group of individuals represented by LeRoy H. Hines, San Francisco petroleum consultant.

Other major oil companies holding acreage in the Kenai Peninsula are Standard Oil Co. of California, Union Oil Co. of California, Ohio Oil Co., Richfield Oil Corp., and Shell Oil Co.

Bomb-Damaged Well?

PUEBLO, Colo.—K-D Drilling Co. is planning to sue the Atomic Energy Commission for damage to an oil well it says resulted from the March 8 atom-bomb test in Nevada.

D. F. Raifsnyder, drilling superintendent, said 10-in. casing in a well 20 miles east of Escalante, Utah, was crushed at 1,135 ft. by an earth tremor caused by the explosion.

Raifsnyder said ground around the well trembled about 20 minutes after the blast. The drilling crew lost a week in removing the casing and cleaning the hole, he added.

Highlights . . . from Oil-Company Annual Statements

"The sustained growth of the business in 1954 required capital and exploratory expenditures of $281,000,000. Because of ever-growing need for petroleum products, the company plans to increase its 1955 outlays to around $300,000,000.

"In all, as a result of exploration and development, new oil was added to the company's underground stocks in 1954 at over twice the rate of withdrawal.

"There are three main ways to meet competition in the manufacturing end of the oil business; to build plants that will turn out more and better products of the kinds that are rising in public demands; to redesign plants for more efficient cost-cutting operations; and to venture into new, but related, processes that promise profitable returns."—*Standard Oil Co. of California.*

"The success of drilling offshore in the Gulf of Mexico to date substantiates the industry's opinion that this area is the largest prospective source of oil and gas reserves within the United States."—*Tide Water Associated Oil Co.*

"Product prices are, as usual, the major source of uncertainty as to earnings in an industry as competitive as ours. Continued increases in cost, especially those resulting from higher octane numbers in gasoline and other quality improvements, must be recovered in the form of higher prices if the industry is to continue healthy."—*Standard Oil Co. (Ind.)*

"The setback which occurred in the latter part of 1953 and which carried over to the first part of the next year was partly righted but further self-restraint is needed in order for the industry to regain its former momentum. A few of the matters which need attention are:

"1. Refinery runs must be more definitely related to product demand.

"2. There must be a better interrelationship reached between the price of gasoline and intermediate products.

"3. Differentials in the price of premium gasoline and housebrand gasoline must be increased for as octane advance, manufacturing costs advance more rapidly and old measures of differentials are no longer applicable.

"4. Curbs on imports of crude oil are vitally necessary in order to avoid increasing dependency on foreign oil and to encourage the continuation of exploratory activities within the United States which actions, in turn, will tend to preserve a strong domestic industry."—*Anderson-Prichard Oil Corp.*

"The chief problem of your company and of the California petroleum industry as a whole has been to ensure for the future an adequate supply of crude oil of good refining quality. There has not been a single large oil field discovered in California since the discovery of South Cuyama field in 1949 by Richfield.

"During the last 5 years, although the industry has drilled approximately 2,800 exploratory or "wildcat" wells in California, there have been discovered in this state only five new oil pools having a proved reserve estimated in excess of 10 million barrels; and of those only one has a proved reserve estimated to be as high as 40 million barrels . . .

"It has been estimated that if during the next 10 years additions to proved reserves in California do not average more per year than they have averaged during the last 5 years, demand will exceed production in California by more than 500,000 bbl. per day. To the extent that demand exceeds such production, California refineries will have to bring oil from other states or from other countries."—*Richfield Oil Corp.*

"Earnings were adversely affected in 1954 by more severe proration in the oil producing states, reduced tanker rates, and lower prices of refined products.

"Long-range oil and gas exploration activities resulted last year in a series of 26 oil and gas discoveries which added substantially to existing reserves, and hold high promise for the future."—*Cities Service Co.*

"Taxes paid by the petroleum industry and its customers in the year 1954 are estimated to have exceeded the total federal tax receipts from all sources in 1937. State, federal, and local taxes collected by the petroleum industry from its customers in the year 1954 exceeded $3,000,000,000."—*South Penn Oil Co.*

CANADA

Texaco Successful Bidder

REGINA, Sask.—Texaco Exploration Co. was the successful bidder recently for 93,400 wildcat acres in western Saskatchewan. The firm bid $103,000 on a block in the Rosetown area, 18 miles east of the Brock-D'Arcy Viking sand gas fields.

Canadian Export Gas, Ltd., purchased 92,960 acres in the Fox Valley area for a $45,616 bonus. The block lies 24 miles north of the Hatton gas field and 20 miles south of the Viking sand gas discovery in the Prelate area.

Canadian Gulf Oil Co. was awarded the only other parcel bid for a bonus of $10,121. The company's offer covered 100,000 acres in the Sceptre area about 10 miles from the Prelate gas strike.

Canadian Export Gas picked up two more blocks for 2 cents an acre annual rental. They include 95,728 acres in the Chamberlain area and 93,360 acres in the Findlater area.

In another sale, Amerada Petroleum Corp. has won leases on scattered wildcat acreage in southwestern Manitoba on a blanket bid of $152,844. The tracts totaled about 16,500 acres.

Peace River Wins Permit

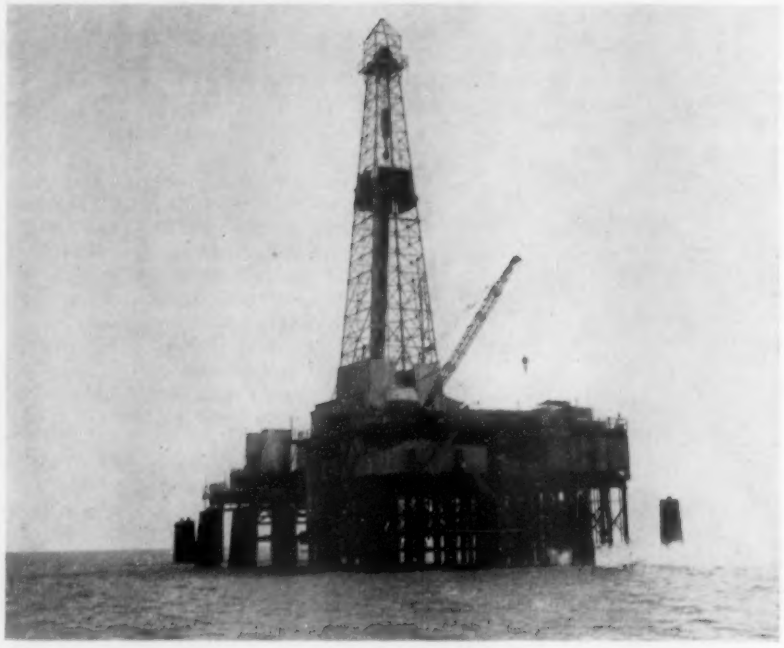
EDMONTON, Alta.—Peace River Oil Pipe Line Co., Ltd., has been granted a permit to lay a 106-mile crude-oil pipeline from the Sturgeon Lake field in northwest Alberta to the Edson pumping station of the Trans Mountain Oil Pipe Line Co., Ltd. The project will include 16-in. line from Sturgeon Lake to Iosegun Lake and a 12-in. line to Edson with maximum capacity of 57,600 bbl. daily.

Canadian Gulf Pipe Line Co. will be operator of the line. The project is backed by a group of major and independent oil companies holding interests in the area. Starting date and financial arrangements have not been announced.

D'Arcy Expands in Canada

CALGARY. — D'Arcy Exploration Co., Ltd., will increase its interest in Triad Oil Co., Ltd., to 50 per cent.

D'Arcy will buy 4,800,000 shares of additional treasury stock. The transaction will increase D'Arcy's investment in Triad to $19,599,250. D'Arcy is a subsidiary of British Petroleum Co., Ltd., formerly Anglo-Iranian Oil Co., Ltd.



Development Continues Off Louisiana Coast

This rig owned by Loffland Bros. Co. is drilling for Pure Oil Co. off the coast of St. Mary Parish, Louisiana, about 40 miles southwest of Morgan City, La. Pure recently completed its ninth gas-condensate producer in Block 32 field there. Three Caterpillar diesel engines power the draw works and mud pump on the rig. Pure also has completed a new gas-condensate discovery in Block 147 off the coast of Iberia Parish, 9 miles northwest of nearest production in Block 45, Eugene Island area. The company last week announced its first oil discovery off the coast of Texas. The well, in Block 189, about 11 miles from Galveston, flowed 37.8°-gravity oil at the rate of 150 bbl. daily through ⅛-in. choke. Production is from interval at 7,522-28 ft.

Industry Briefs

CLEVELAND. — Standard Oil Co. (Ohio) is inviting bids for an 11,000-bbl. per day catalytic-reforming unit to be built at its Cleveland refinery. Sohio will consider both fixed-bed and moving-bed processes. Cost of the project, including auxiliary equipment, is expected to be about $5,000.000.

SAN FRANCISCO. — Tide Water Associated Oil Co.'s Avon Flying A refinery here has completed 4 million man-hours of work without a disabling injury. The achievement surpasses the previous accident-free mark of 3,973,-204 man-hours for California oil refineries.

NEW YORK.—The Texas Co. has ordered its fifth high-speed "New York Class" tanker. The 18,500-ton vessel will carry more than 153,000 bbl. at a sustained speed of 18 knots. Newport News Shipbuilding & Dry Dock Co. will deliver the ship in mid-1956.

KIMBALL, Neb. — Kimball Gas Products Co. of Odessa, Tex., plans to start work next month constructing a $1,000,000 absorption-type gasoline plant in the Long field in southern Kimball County, Nebraska. Initial plant capacity will be 7,500,000 cu. ft. of wet gas daily from Long, Enders, and Dietz fields. Daily liquid production is expected to total 10,000 gal. of gasoline, 12,000 of butane, and 15,000 of propane.

EL DORADO, Kan.—Skelly Oil Co. is gradually putting into production a new Platformer at its 45,000-bbl. refinery here. The 8,500-bbl. capacity unit was installed to step up output and quality of Skelly products. Skelly has a similar unit in operation at its Longview, Tex., plant and is building another at its Denver refinery.

WASHINGTON.—The Government of Iraq paid off a $6,300,000 loan from the International Bank for Reconstruction and Development last month. Oil money made it possible to clean up the debt 10 years before it was due. Iraq borrowed the money in 1950 for a flood control project. Since then its oil income has increased fivefold.

TIPRO Supports Neely

Association also endorses bill amending Natural Gas Act and continues fight for state economic-waste legislation

Henry D. Ralph

FORT WORTH.—Federal legislation to curtail imports of crude oil and to exempt natural-gas producers from federal control was demanded in vigorous terms last week by the Texas Independent Producers and Royalty Owners Association.

At its annual meeting here TIPRO specifically endorsed the Harris bill to amend the Natural Gas Act and the Neely amendment to provide an oil-import quota in the Reciprocal Trade Agreements Act.

It also voted to continue working for the economic-waste bill now pending in the Texas Legislature. The measure would empower the Railroad Commission to prevent the sale of gas at prices so low as to create waste.

On both the gas and the import issues, some members questioned whether the association should change its stand, but after considerable debate the group agreed to adhere to previous TIPRO policies.

Stand on imports . . . Continued support of the Neely amendment was questioned on the basis of The Oil and Gas Journal article of March 21 which pointed out that the 10 per cent limitation would fall mostly on residual fuel oil and that crude imports would be cut relatively little.

It was finally agreed that the legislation has advanced so far in Congress that it is too late to try to evolve a different plan. Enactment of the Neely amendment would at least establish the principle of legislative curtailment of oil imports, it was pointed out. The TIPRO resolution also included a request that Congress strengthen escape clauses of the act to permit the Tariff Commission to give relief to any domestic industry hurt by imports.

Members were outspokenly critical of some Texas congressmen for failure to support amendments opening the way for curtailing oil imports.

Debate on gas . . . The argument over gas controls revolved around TIPRO's drive for state legislation. Objections have been raised, both in Texas and in Washington, that the state bill, which would in effect set minimum field prices for gas, was endangering the Harris bill. Some argued that the Texas measure was ill-timed because opponents could say that in the absence of federal control the producing states would immediately raise all gas prices.

ALWYN P. KING, JR.
. . . New TIPRO President

TIPRO refused to change its stand, however. It contended that in the absence of state action there would be little hope of getting an increase in very low prices in older fields or in ending discrimination in some areas. The fact that Oklahoma and Kansas have minimum-price laws, it was said, causes some pipelines to draw excessively from fields in the Texas Panhandle where old contracts stipulate much lower prices.

Great indignation was expressed over a current controversy in which Lone Star Gas Co. is opposing an offer of Natural Gas Pipe Line Co. of America to pay 15 cents per M.c.f. for certain Texas gas because Lone Star is paying only 11 cents.

Recognition . . . Alwyn P. King, Jr., Houston independent, was elected president of the association, succeeding Jack Woodward. King had served during the past year as a district vice president and as state membership chairman for TIPRO.

G. Scott Hammonds, Dallas independent, was named secretary, and William T. Beard, Jr., was reelected treasurer.

TIPRO's annual award of recognition was given to Walter S. Hallanan, president of Plymouth Oil Co. and chairman of the National Petroleum Council. In his speech of acceptance, Hallanan dwelt heavily on injury from excessive imports. He said there is no hope of remedying this condition without restrictive legislation.

Other resolutions adopted denounced all attempts to promote compulsory unitization and urged increased salaries for members of the Texas Railroad Commission.

Gas Plant Opened

United's Cabeza Creek unit serves 26 fields

RUNGE, Tex.—United Gas Pipe Line Co. has put in full operation its big new Cabeza Creek natural-gasoline plant 8 miles southeast of here in Karnes County, South Texas.

The plant at capacity will process 100,000,000 cu. ft. of gas daily from 26 fields in the Cabeza Creek and Hordes Creek areas. They cover most of Goliad County and portions of Karnes and DeWitt counties.

Products will include 45,000 gal. of L.P.G. and about 25,000 gal. of debutanized gasoline a day.

The Cabeza Creek facility is the second largest of the company's seven natural-gasoline plants, ranking behind only the huge Carthage field plant in East Texas.

It had been in partial operation since last November when dehydration facilities were placed on stream. These facilities included two 55,000-M.c.f. three-bed packaged dehydrators. They are the adsorption type, using a solid desiccant to remove water vapor.

Dry gas from the plant will be sent through United Gas Pipe Line's 16-in. line 6 miles west of the plant to a tie-in with the firm's 16-in. Pettus-to-Converse, Tex., carrier. The 16-in. line from the plant also will tie in with the company's 20-in. Burnell-to-Converse line about 2½ miles west of the Pettus-Converse junction.

The 26 fields from which the plant will gather and process wet gas are: Slick-Wilcox, Albrecht, Boyce, Brandt, Breeden, Cabeza Creek, East Melrose, Gottschalt, Melrose, Poehler, South Cabeza Creek, South Weesatche, Weesatche, West Weesatche, Marshall, West Boyce, Heinzeville, North Charco, Hordes Creek, Gladys Powell, River, Emma Haynes, South Porter, Pargman, Wester, and East Slick-Wilcox.

I.P.A.A. Still Backs Neely Bill . . .

The Independent Petroleum Association of America takes issue with the editorial, "This Import Quota Is No Good," and an article, "Coal, Not Oil, Will Win If the Neely Bill Passes," which appeared in the March 21 issue of the Journal. On these pages is the I.P.A.A. position as presented by W. M. Vaughey, president of the association. It is followed by the reply of P. C. Lauinger, publisher of the Journal.

March 23, 1955

Mr. P. C. Lauinger, Publisher
The Oil and Gas Journal.

Dear Sir:

I am disappointed that you published your editorial in your March 21, 1955, issue . . . entitled "This Import Quota Is No Good," without first conferring with those in the industry who have supported this legislation proposed by Senator Neely and 16 other United States Senators. . .

The petroleum industry has long looked to your publication for wise counsel and constructive criticism and advice. It is because of this earned position which you have enjoyed that I am concerned, and consider what you have done unfortunate for both of us. No one group in the industry can expect you always to agree with it on activities or solutions, in connection with the many industry problems on which there are differences of opinion. I am sure that you will agree that every group has a right to expect that you will deal with the facts of each case fully and objectively. I am equally sure that you will respect my right and obligation to point out certain serious errors and implications made in both your editorial and the statistical article which was meant to support same.

Specifically, I feel that there will be many informed persons who will take exception to your analysis for the following reasons:

. . . Your editorial overlooks the fact that most domestic producers are concerned with establishing a fair and assured restraint on future imports. Thus, the domestic industry will have the opportunity to grow, in keeping with increasing petroleum demands. This is more important than the immediate effect of legislation on the exact volume of current imports. The basic principle of the Neely amendment is to establish a fair relationship between imports and the domestic industry.

. . . Your statement that domestic oil producers "let the coal people draft their legislation" is not true. Furthermore, it is discrediting to the many persons and groups having long experience who have participated in this effort. These people are engaged in the domestic oil industry. Their combined experience covers many years of considering similar legislation, such as the Thomas bill in 1950 and the Simpson bill in 1953; and as a result, it culminated in the full support of the Neely amendment by these 21 oil and gas associations after long study.

. . . Your statistics, based on an erroneous interpreta-tion of the Neely amendment, lead you to the incorrect conclusion that this legislation "would cut crude oil imports a mere 66,000 bbl. per day" from 1954 to 1955. As shown below, the actual cut in 1955 crude imports would be 135,000 bbl. daily below the 1954 level, and 239,000 bbl. daily below the 1955 program, as reported to the Texas Railroad Commission in February of this year.

. . . I hope that you will reconsider your use of such terms as "big joker," "booby trap," "cat's paw," "suckers" and "dupes" in connection with this legislation and its supporters, as reflecting on the ability and integrity of sincere men in our industry, as well as respected leaders in our Government. From within both industry and Government, responsible men have subscribed to the recent report of the Cabinet Committee on Energy Supplies and Resources Policy, which embodies the basic principles of the Neely amendment.

In the statistical article on pages 121 and 122, which attempts to interpret the Neely amendment, the figures are correct as to the limitation on total 1955 imports of crude oil and products. Based on the 1954 domestic demand, total 1955 imports of crude oil and refined products would be limited to 10 per cent of that demand, or 775,000 bbl. daily. Your figures are incorrect, however, for crude oil and residual fuel oil.

After limiting total imports (including oil for supplies of vessels) to 10 per cent of domestic demand, the Neely amendment provides a special limitation on residual fuel oil imports. You failed to note that the special limitation on residual fuel does not deal with residual fuel oils imported for supplies of vessels, which do not compete with coal. The limitation applies only to residual fuel imported "for consumption therein," that is, within the United States. Under the amendment, therefore, residual fuel oil could be imported in an amount equal to 10 per cent of domestic residual demand, PLUS imports for supplies of vessels, as long as these imports remained within the limitation on total imports of crude and products. Based on past experience, it would be expected that fuel oil for vessels would continue to be imported at about the 1954 level. A correct calculation of the 1955 import allowables, under the Neely amendment, therefore, is as follows:

	Neely amendment import allowables in 1955 (bbl. daily)
Total crude and refined products (10 per cent of 1954 domestic demand)	775,000
Residual fuel oil, not including imports for vessels (10 per cent of 1954 domestic demand for residual)	143,000
Residual fuel oil imports for vessels (assumed to continue at 1954 level)	68,000
Total residual fuel oil imports	211,000
Other refined products (assumed to continue at 1954 level)	43,000
Crude oil (balance of total allowable)	521,000

You will note that a total of 211,000 bbl. daily of residual fuel oil could be imported, in contrast to the 143,000 bbl. used in your analysis. After allowing for the imports of other refined products, such as asphalt, the remainder of the over-all quota would be 521,000 bbl. daily available for crude oil imports.

The downward adjustment of imports under the Neely amendment, therefore, would be quite different than shown

in your article. The reductions in 1955, from the actual 1954 levels and from the levels previously scheduled by the importing companies for the first 6 months of 1955, would be as follows:

	From 1954 level of 1,052,000 bbl. daily	From company programs of 1,230,000 bbl. daily for first 6 mo. 1955
Crude oil	—135,000	—239,000
Residual fuel oil	—142,000	—216,000
Other products		
Total	—277,000	—455,000

You will note that these reductions are divided about equally between crude oil and residual fuel oil. Actually, the largest reduction is in crude oil imports, as previously scheduled for this year. In contrast to conclusions in your editorial, such reductions would be significant to domestic oil producers. Incidentally, this interpretation was supported by representatives of the coal industry before the House ways and means committee.

Even more important than the exact figures, these proposed adjustments would establish a stable relationship that would prevent imports from taking an ever-increasing share of the United States market in the future.

The National Petroleum Council, President Eisenhower's Cabinet Committee on Energy Supplies and Resources Policy, as well as the domestic oil industry have recognized that imports of both crude oil and refined products can depress and restrict the domestic oil industry. The basis for the over-all 10 per cent and the special residual fuel oil quota is exactly the same. This is the ratio that actually existed during the 6 years of 1946 through 1951. The Neely amendment and the cabinet committee's report both recognize the advisability of treating imports of crude oil and residual fuel on an equal and comparable basis.

Fair analysis of the principles in the Neely amendment should be helpful. It is important that the fullest possible understanding of the proposal be had by all concerned. If your Mr. John C. Casper is correct, or if there is reasonable doubt that the language now employed in the Neely amendment does not accomplish the principal purpose of relating oil imports to domestic production, the language of the proposal can be corrected or improved before its final adoption.

I am glad that we have reached common agreement that imports are too high, and as you have stated, should be reduced by some means. . .

Because you have disagreed with our attempted answer to this problem, I am interested in knowing what your solution would be. To be of any help to us, it should be specific. . .

Very truly yours,

W. M. VAUGHEY, President
Independent Petroleum Association
of America.

. . . But the Journal Still Is Opposed

March 30, 1955.

Mr. W. M. Vaughey, President
Independent Petroleum Association
of America

Dear Mr. Vaughey:

I want to thank you for your letter in which you disagreed with our March 21 story on the Neely amendment. I know your letter reflected the views of many respected and sincere members of the oil industry.

We have studied thoroughly and open-mindedly your criticisms. We have also reviewed our own thinking. We have reached these conclusions:

. . . Our original figures are accurate. They are different from yours for two reasons: (a) We based our conclusions on actual imports in 1954; you used estimated figures for 1955. (b) We interpreted the amendment as including imported ships' fuel in domestic consumption; you interpreted it as excluding bunkers. We still feel that we are right; that actual figures are more sound than estimates. We would like to point out that since your letter was written, the importing companies have again reported to the Texas Railroad Commission. Their latest figures are below those for February, which you used.

. . . We believe our interpretation of the Neely amendment, as now written, is justified. Senator Neely has told us that the intent of the bill is to exclude ships' fuel when figuring residual imports into this country. The wording of the bill, however, is not this clear.

Bunker fuel is included in domestic demand figures of the Bureau of Mines. It is included by the Department of Commerce in "United States Imports of Merchandise for Consumption." It is considered a part of domestic sales by marketing companies. Therefore, we believe that the use of the term "therein" to mean consumption within the boundaries of the United States is no guarantee that it will be so interpreted.

It would be unwise, we believe, to depend upon the intent of the bill's authors when the language can be interpreted to mean opposite things. The Natural Gas Act is a striking example. Not only Congress, but the Federal Power Commission, interpreted the law as not covering independent producers. This was no assurance. The Supreme Court, alone among all government bodies, disagreed. The cost and confusion which resulted is only too well known to everyone.

. . . There still are "if's," ignored until now, which could completely nullify any advantage the bill might have for the oil industry, even with the most favorable interpretation.

The importers could, for example, start bunkering ships in Europe. This would mean that for every barrel of residual not imported for this purpose, they could bring in another barrel of crude. The law would permit this because bunker fuel specifically is included in the over-all 10 per cent limit, even though it may be considered excluded in the residual quota.

In other words, there is nothing in the Neely amendment to prevent importing companies from using the full 10 per cent quota for crude oil. The bill is aimed at limiting the flow of foreign crude. But because of the confusing quota within a quota for residual, it does not do that. There is no actual guarantee of any relief for the domestic producer.

For these reasons, the Journal is still emphatic in its belief that the Neely amendment is a bad piece of legislation for the oil industry. Even if we accepted your mathematical approach, and assuming your interpretation to be correct, we are certain the bill would not accomplish the desired ends. We feel that it is compromise legislation in which the coal industry would get great benefit and the oil producers only token assistance.

Sincerely,

P. C. LAUINGER, Publisher
The Oil and Gas Journal.

Congress Gets Facts

Pipeliners want changes in Harris bill; committee told control of field price won't insure low consumer rates

Bertram F. Linz

WASHINGTON. — Natural-gas producers, pipeliners, and investors told the House interstate commerce committee some facts of life last week.

It isn't the price of gas in the field that makes consumer rates high, they said. It's the cost of getting the gas where it is used. Producer regulation won't keep rates down. Competition is the best restraining influence. And the Harris bill will make wider competition.

Gas production is not monopolized by a few big companies, John W. Boatright of Standard Oil Co. (Ind.), insisted. About 4,100 producers are now selling to the interstate pipelines. But there are 4,000 other producers. Any or all of them might make interstate sales at any time.

On the other hand, Boatright said, the 20 largest companies account for only 46 per cent of the gas produced. The first 100 companies have no more than 78 per cent.

Boatright was lead-off man on the industry side. He warned the committee that federal regulation of producers will mean less hunting for new gas. He said it isn't known yet whether the Phillips case has affected exploration. But in the 5 years after the war, three times as much new gas was found as was produced. In the last 5 years, new gas supply has averaged less than twice the amount produced. Last year the increase was only slightly more than was used.

A number of producers listed to speak filed statements instead in a move to speed the hearings. They included Clarence T. Smith, Flora, Ill., lawyer and independent oil producer; J. P. Jones, Bradford, Pa., former president of the National Stripper Well Association; R. G. Lawton, Magnolia, Ark., formerly production director for the Petroleum Administration for Defense; and Russell B. Brown, general counsel for the Independent Petroleum Association of America.

They took the position that small producers will not be able to look for new gas if they have to stand the losses from dry holes and have their earnings limited on successful ventures.

Lawton told the committee that only one well out of 967 drilled discovers a major field. Exploratory wells often cost $500,000 or more. A dry hole means not only loss of the drilling cost, but of investments in leases around the well which may be proved worthless. These leases may cover thousands of acres and cost more than the well, he said.

Brown said no form of regulation can be devised that will meet the peculiar needs of oil and gas production. There are only two methods, a public utility basis or some arbitrary basis. Neither is just or reasonable for fixing producers' prices.

Brown predicted that if the producer is allowed only a fixed return on his investment, he will either go bankrupt, have to stop hunting for new gas, or pay for exploration out of any crude oil he may produce.

Pipeliners speak . . . The interstate pipelines will price themselves out of the market if they pay too much for gas or it costs too much to transport it, John F. Merriam, president of Northern Natural Gas Co. and president of the Independent Natural Gas Association of America, said.

On the other hand, he added, "if we can't buy enough gas it does no good to have nice low prices if no one who wants the gas can get it."

The pipelines can't afford to let the price go up to the point where they go out of business, Merriam said. But under the Phillips decision, the producer will not know how much he can or will get for gas he sells in interstate commerce. The result will be a slowing down of the volume of gas offered for interstate sale. Producers will send their gas to the unregulated markets in their own state. When those markets are satisfied there will be less incentive to look for more gas.

Proposed changes . . . Merriam outlined changes in the Harris bill which the pipeline companies think will give equal protection to producers, transmission systems, and consumers.

The changes will free the producer from Federal Power Commission control at the same time leaving the FPC power to pass on the prices paid by pipelines. This will make the purchase of new gas slower and more difficult, he said, but it will protect the consumer against unreasonable increases in gas prices.

The pipelines want these changes in the bill:

. . . Renegotiation of present contracts should not be considered as making new contracts. If the FPC is allowed to rule on renegotiations it could mean future bankruptcy of many interstate lines. The lines would be committed by the provisions of the contracts but the FPC could refuse to let them recoup such costs.

. . . Advance FPC approval of the field price of gas in new contracts is provided in the Harris bill. The wording should be changed to let the commission decide whether the contracts meet the standards set up.

. . . Some reasonable method should be provided for the pipelines to determine the reasonableness of the field price when they enter into new contracts and before any commitments are made by either the pipeline or producer.

. . . The competitive situation should be a factor in the FPC's decision whether the market price is reasonable.

Investors . . . Investors will shy away from the gas industry if producers are regulated, the Investors League said in a statement.

They see regulation as a blow to freedom of enterprise and a possible entering wedge to the extension of socialistic regimentation. If natural gas production remains subject to regulation no segment of industry is logically exempt, the statement said.

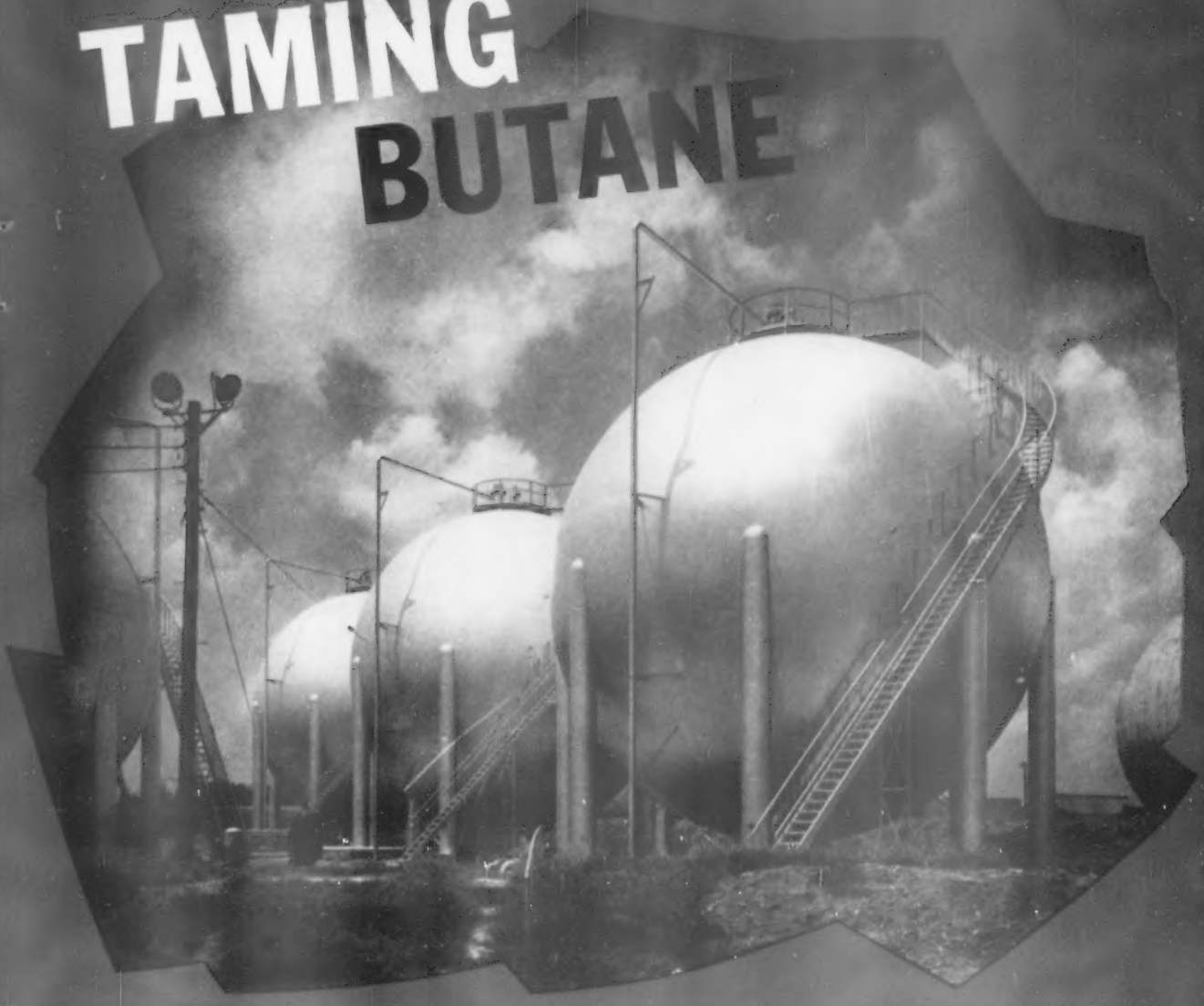
Nothing would be gained by regulation, it said. It would not lower the price of gas appreciably. Only about 10 per cent of the cost goes for production. If anything, that cost will increase as supplies diminish.

The opposition next . . . With the industry's side of the case heard, opponents of the Harris bill will get their day.

Coal producers, while not directly opposing the Harris bill, want much broader changes in the Natural Gas Act, including FPC control over direct industrial sales. They claim these sales involve the "dumping" of gas at cost or lower and are unfair competition with coal.

The consumer interests will want to kill the Harris bill. They will support the Heselton bills. One of these calls for affirmation of the Phillips decision. Another would limit FPC control to producers selling more than 2,000,000 M.c.f. of gas interstate an-

TAMING BUTANE



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WATCHING WASHINGTON

Bertram F. Linz

FPC Waits for Congress

The Federal Power Commission has fixed it so a number of issues will not come up for decision until about the time Congress disposes of the Harris bill.

If the bill is passed and the independent producers are freed from federal regulation, the commission will be able to drop these matters. If the bill fails, the FPC can go ahead quickly with regulation.

About the end of June the FPC will have finished studies of such matters as whether casinghead gas —and possibly wellhead sales as a whole—are subject to price regulation; the stand to be taken on abandonments of service, which involves questions of state conservation; and the propriety of escalation and favored-nation clauses in sales contracts.

These are just a few of the questions which must be answered if the Supreme Court order to regulate producers is to be carried out. If the Phillips decision is overruled by Congress, they will be just talking points rather than issues. It would seem that the FPC feels that much confusion and expense will be prevented if these matters are handled slowly.

As a matter of fact, the FPC could hardly dispose of these cases immediately. The machinery works pretty slowly—first the presentation of the case then a recess so the staff can make a study; then cross-examination, the appearance of intervenors and other interested parties, and another recess; then argument and, finally, a decision.

"Raiding" Curb Sought

Congress was asked last week to halt the raiding of corporations by financial "buccaneers."

It's the idea of Rep. Thomas J. Dodd of Connecticut. A fight is going on for control of a big firm, Niles-Bement-Pond Co. in that state. Penn-Texas Corp., which controls companies operating in oil and gas leases and other lines, bought into the company last year and wants seats on the board.

Oil companies have been the victims of raids in the past, Dodd said. An early example was the wartime purchase of Panhandle Producing & Refinery Corp. by the recently murdered Serge Rubenstein and his associates. Lawsuits have made it clear that Rubenstein was milking the company heavily, Dodd said.

Rubenstein also was charged some years ago, with others, with conspiring to gain controlling seats on the board of Stanwell Oil & Gas, Ltd. of Toronto, Can. These suits are still pending.

Dodd has written a bill which he hopes will touch off a probe of financial raiding. No industry is safe from raiders seeking companies with big surpluses which can be distributed by unconservative directorates, he says.

Many of these companies are important to national defense. They should be protected against raiders. But Dodd emphasized there is a line between the "pushing and hauling" of financial interests with legitimate and constructive purposes and raids to milk a company or put it out of business.

Cartel Suit Worries Coal

The coal industry wants to know what ever happened to the cartel suit.

The recently published United Nations report on European oil prices recalled that a suit, based on the Federal Trade Commission's study of 1952, was filed in New York nearly 2 years ago.

Joseph E. Moody, president of the Southern Coal Producers' Association, told a Senate committee last week the suit seems to be dying on the vine. Nothing has been heard of it, he said, except that once in a while somebody says talks are going on between the Government and the companies.

Moody thinks somebody should look into the matter. He said there should be an immediate congressional inquiry to find out why the suit is being delayed.

There was no immediate sign that Congress is disturbed about the case. There has been nothing unusual in its handling. A lot of suits have been kicked around much longer before they get to trial.

nually. Heselton claims this would take all but 100 or so of the largest producers from under the FPC.

It is already clear that if Congress does pass a gas bill this year it will not be the Harris bill as written by the Arkansas congressman. It will carry out the main idea of releasing the independent producers. But it will have to be broadened to include the suggestions of the pipelines on escalation, field price and several other matters. To get the support from the coal states necessary for passage, it will also have to include some of the changes the coal industry is asking.

Compact Attacked

Minority report also hits proration, Iranian oil deal

WASHINGTON.—The federal Government has surrendered too much of its authority over the oil industry, it was charged last week.

A minority of the attorney general's antitrust law study committee said the Interstate Oil Compact and the administration-approved Iranian consortium were instances where the Government had forfeited its antitrust powers.

The group said congressional approval of the Interstate Oil Compact enabled producing states to set up a system of price maintenance. Those states control the price the rest of the country must pay for oil. They attempt to control imports by threatening to cut allowables.

"State regulation of production long ago detached itself from engineering considerations and proceeds primarily on the basis of realizing a profitable price for most producers," the minority said.

The minority also charged the "international cartel" set up to handle Iranian oil may be the right answer, from the military-diplomatic view, but said there are big objections from the standpoint of antitrust policy.

"This executive exemption contained no conditions designed to safeguard the public interest or the interest of American oil refiners who must buy foreign crude," the minority said.

The minority disclosed that the committee, by a narrow margin, refused to support an international agreement to protect against exploitation by foreign cartels. A majority of the committee called for a "rule of reason" in applying the antitrust laws against companies operating abroad. It held they should not be subjected to the laws if they can show they acted only to meet the requirements of foreign operation and not to place an undue restraint on our foreign commerce.

Gas Business Better

FPC says gas pipelines showed increase in 1954

WASHINGTON.—The interstate natural-gas pipelines did a bigger business and made more money in 1954.

They had 4 per cent more customers, handled nearly 9 per cent more gas and had a 14 per cent higher revenue than in 1953, the Federal Power Commission said last week. Their expenses were 17 per cent greater, but their gross income was up 14.6 per cent and their net income 7 per cent.

The 35 systems under FPC regulation bought 6,012,603,000 M.c.f. of gas last year compared to 5,525,454,000 M.c.f. in 1953. They sold 6,215,736,000 M.c.f. against 5,730,904,000 M.c.f.

Most of the gas, of course, went to gas utilities for resale. The revenue from such sales was $1,285,716,673 against $1,117,359,247 the previous year. Sales to ultimate consumers brought in $251,705,986 against $225,949,826. Other receipts brought operating revenues to $1,599,923,699, 14 per cent increase over the $1,403,593,128 for 1953.

The companies paid $781,046,186 for gas they bought, against $667,939,921 in 1953. Their own production expense was $27,359,273 against $16,011,747. Other costs brought their total expenses to $1,029,741,845 against $880,955,246.

Import Sessions Begin

WASHINGTON. — The Senate finance committee began secret sessions on extension of the Reciprocal Trade Act last week with three points to decide.

Two are fairly easy. They are whether the program should be continued for 3 years and whether the President should be allowed to make further cuts in duties.

The big fight is over a third point. That is what can be done to protect the oil, coal, and other industries against a flood of imports.

Sen. Neely of West Virginia wants to bring oil imports down to 10 per cent of domestic consumption. The administration is fighting any change of any kind in the law. It has been arguing it is perfectly all right as it is. Domestic oil producers made a strong case at the committee hearings. They are confident that something will be written into the bill to keep imports under control.

Gasoline Tax May Go Up

WASHINGTON.—It will be all right with the Treasury if the gasoline tax is hiked to pay for some new roads.

The administration's $101-billion highway program calls for a bond issue to cover part of the cost. The bonds would be paid off through tolls. Secretary Humphrey told the Senate public works committee there are several kinds of tolls. A practical one is by measuring them by the consumption of motor fuel.

"I would not object if Congress sees fit to increase the federal gasoline tax to finance this program," Humphrey said.

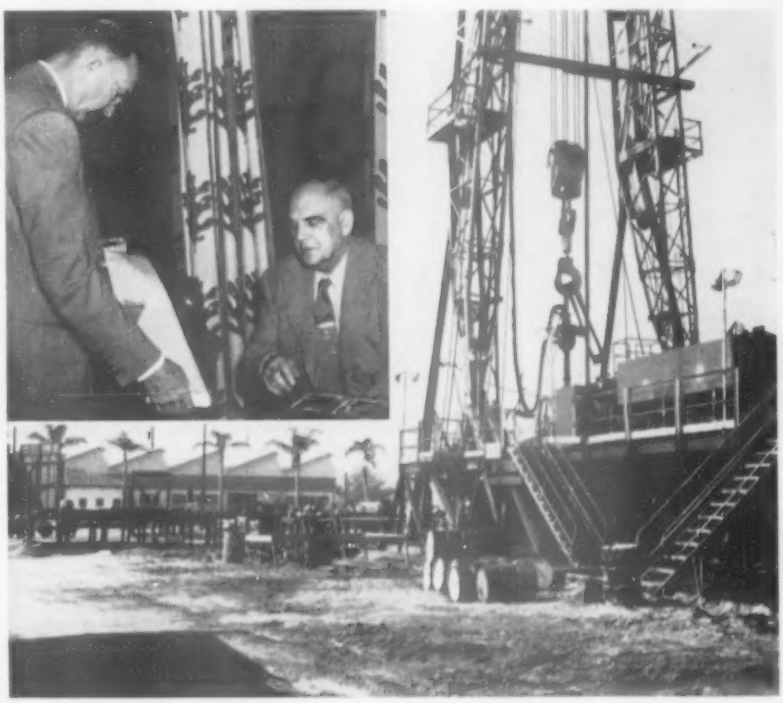
Some congressmen oppose an increase in the tax. They say it would not be a toll for use of the new roads. It would mean that all motorists would help to pay for new highways, even though they never rode them.

Agency to Support Self

WASHINGTON. — The Bureau of Land Management is going to put its leasing work on a self-supporting basis.

Under a new schedule of fees holders of noncompetitive oil and gas rights will have to pay $10 for extension of their leases. No fee is charged now.

Successful bidders for competitive oil and gas leases will pay more. They will pay the cost of publishing the notice of offer. If two or more bidders get leases they will split the cost.



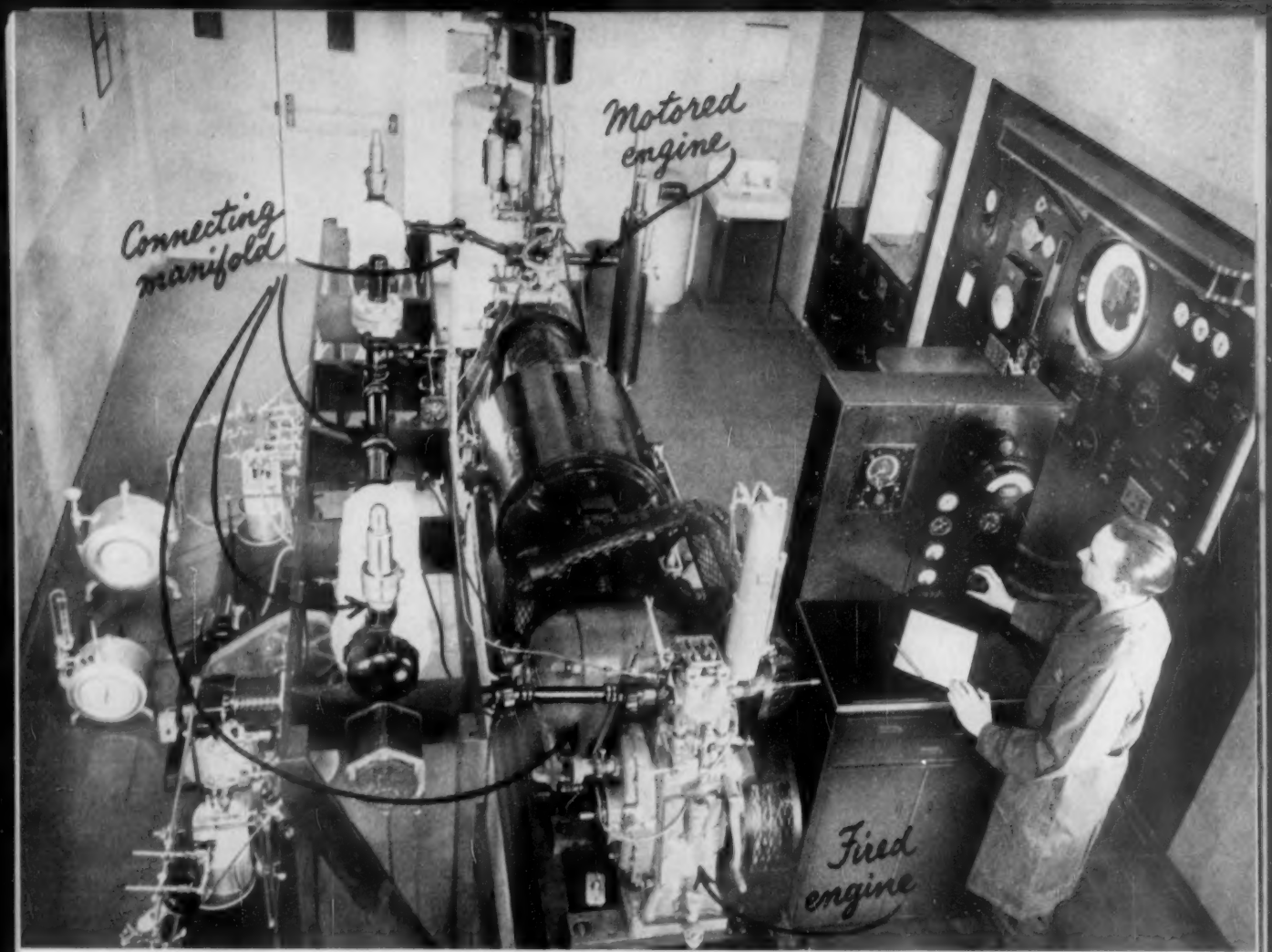
Drilling Progress Remotely Recorded

LONG BEACH.—A well being drilled at the Long Beach Airport pool is giving Elmer Decker, Martin-Decker Corp., the opportunity he has been awaiting for some 30 years.

That is to experiment with the remote recording of drilling progress normally indicated or charted only on the derrick floor. Since the well is being bottomed beneath the company's plant, Decker was able to include provisions in the drilling contract which permit such activities. Only restriction is that his activities must not interfere with drilling contractor.

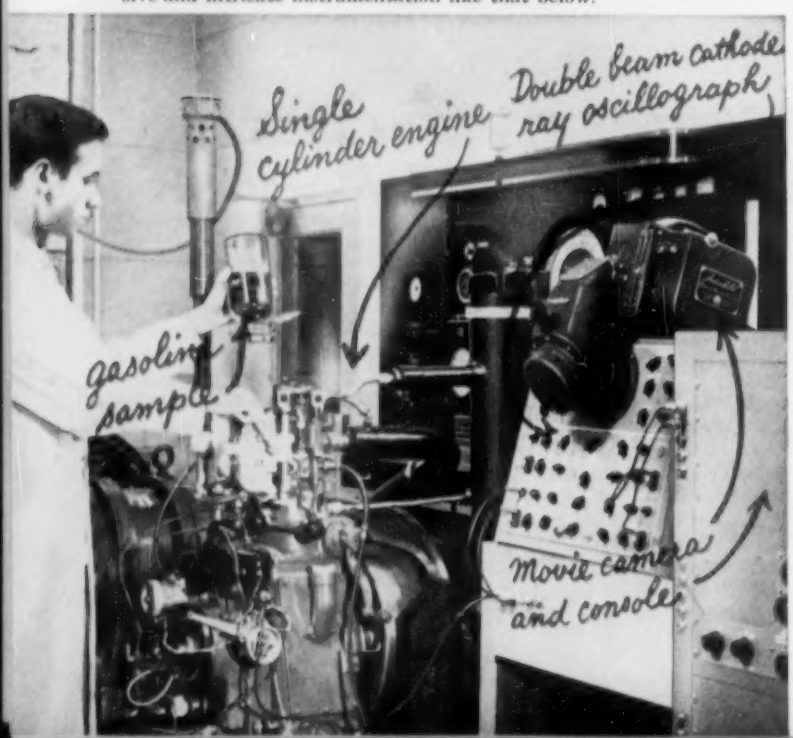
The well, Hancock Oil Co. 60 Signal, is being drilled across Cherry Avenue from the Martin-Decker plant. By means of wires and a recorder, Decker can check on its progress from his desk. Currently only drilling weights are being recorded, but mud pressures and rotary speeds could be charted if desired. Decker is shown above studying a strip chart in his office with Karl L. Kellogg, right.

The 9,000-ft. well is being slant-drilled because the plant site is in a restricted drilling area. Development is being carried out to a 1-acre well spacing pattern because of the extremely thick pay section involved. A 1,400-ft. section containing more than 1,000 ft. of net oil sand is found in some wells.

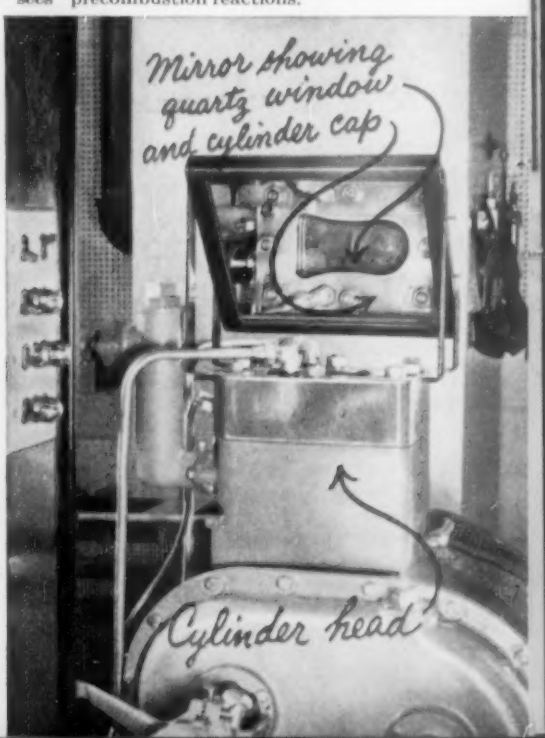


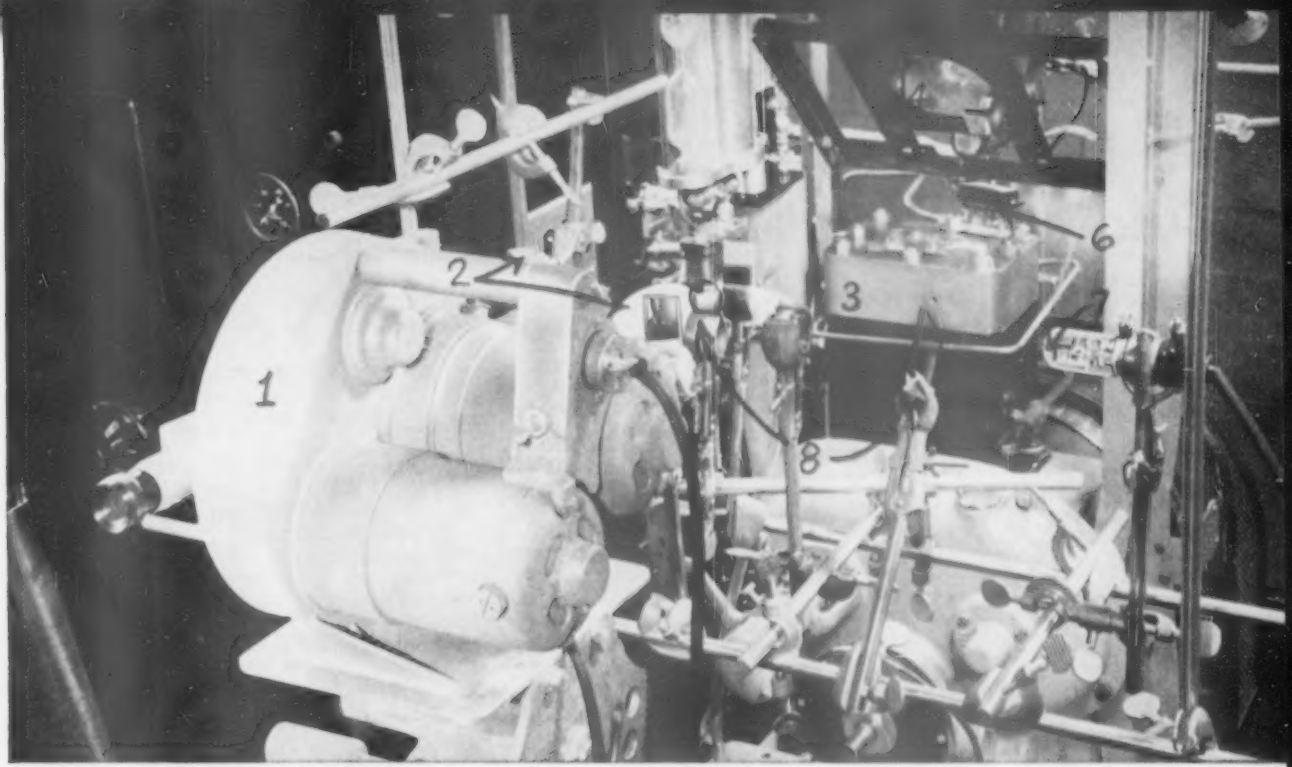
Tandem engine arrangement permits Ethyl Research to produce any desired amount of precombustion reaction by varying compression ratio in a motored engine. The effect of precombustion on knock can then be evaluated in the second engine.

Pressure-time records of modern high-speed engines require expensive and intricate instrumentation like that below.



Direct view of quartz head shows how camera "sees" precombustion reactions.





Complex arrangement of lenses and mirrors permits camera to photograph "cool" flame in engine cylinder utilizing variations in the refractive index of the hot gases. 1. Fastax high-speed movie camera. 2. Mirrors. 3. Cylinder head equipped with quartz window. 4. Mirror showing light reflected from piston top. 5. Synchronizing light. 6. Timing light. 7. Light source—zirconium arc. 8. Optical filters.

Ethyl Research takes a look at precombustion

The instant an air-fuel charge is pulled into the cylinder things begin to happen. The intake valve closes, compression starts—and even before the charge is ignited—important chemical changes take place in the fuel. Just what are these changes? How do they affect the operation of the engine?

Ethyl Research people have been pioneering in this unknown area for years. In their studies they have developed several new techniques, which are helping to fit together the answers.

Among these is a precombustion ("cool" flame) photographic setup using shadowgraph techniques. In this instrumentation a complicated series of lenses and mirrors is arranged so that a high-speed camera capable of 7200 frames a second can photograph "cool" flames in a special test engine. At the same time it picks up flywheel timing marks. A second camera—synchronized with the first—photographs instantaneous pressure traces from the oscilloscope. In this way "cool" flame and pressure records can be precisely correlated.

Another of these special Ethyl instruments is the tandem engine. Here precombustion reactions of different degrees can be made to occur by varying the compression ratio of a motored engine. The reaction products are then rated in a fired engine to find the direct influence of the early reactions on knock.

By analyzing various test results, Ethyl Research has developed a better understanding of precombustion reactions, and thus has added to the general knowledge of the combustion process.

These precombustion studies are an important part of "Ethyl's" basic research program.

ETHYL CORPORATION
Research Laboratories

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Allowable Battle Rages

Oklahoma Legislature asked to impose 25 bbl. per well daily minimum; price control measure also studied

OKLAHOMA CITY.—A controversial bill setting Oklahoma's legal oil allowable at 25 bbl. daily per well on a lease basis has been advanced to final passage in the state House of Representatives. If it passes on a final roll call, the measure then will go to the Senate.

The bill, sponsored by Rep. E. J. Evans of Konawa, is supported by many independents with shallow production and fought by deep-well operators and most major companies.

It is one of several proposals introduced in the legislature. Another also due to touch off stormy debate when it reaches the Senate floor is a sweeping measure controlling the price of crude and forcing common purchasers to buy.

Backers of the legal minimum allowable contend under proration formulas set by the state Corporation Commission that Oklahoma is holding the line on production while importers and operators in other states grab the market. They claim that stacked rigs, idle drilling crews, and smaller royalty checks have resulted in Oklahoma.

Opponents charge the bill would saddle an inflexible allowable policy on the industry and would result in lower allowables for deep wells, forcing a longer payout. These spokesmen also claim an allowable fixed by the Corporation Commission could be changed quickly to meet shifting economic conditions, but if the formula is written into law, it might take months or years for the legislature to remedy a disastrous situation.

Some oil men have opposed putting the allowable policy on a lease basis claiming, under this plan, one good well on a lease could operate at capacity to make up for weak wells unable to produce the minimum allowable.

The Corporation Commission for the first 3 months of the year fixed the minimum allowable at 25 bbl. daily on a lease basis and several purchasers ordered "pipeline proration" to avoid a market glut. The commission, however, cut the April allowable slightly to relieve the problem.

The Rinehart bill . . . Sen. James Rinehart, El Reno, has introduced a double-barreled bill controlling prices and forcing purchasers to buy. He proposes to prohibit sales at a "price below the weighted average prices in all other oil-producing states." The printed bill makes no mention of the economic factors to be considered in "weighting" the average prices.

Chief concern of the Rinehart measure is to force a common purchaser (pipeline) to buy all petroleum in the vicinity of its facilities. The pipeline also would have to buy all oil in the area which may be reached by its facilities and that of its agents or to which lines may be extended.

The state Corporation Commission could order a common purchaser to extend or improve its transportation facilities to any commercial oil well "within a reasonable distance from its existing facilities" or to any well within a territory served by the common purchaser."

Oil men say this provision could mean a pipeline might be allowed to transport oil from a distant well to its gathering lines by truck but the purchaser would have to absorb trucking costs.

The Rinehart bill bars discrimination by pipelines against any one producer as to price, like grades of oil, or in furnishing facilities for transportation. The measure adds: "If a purchaser also is a producer, it is prohibited from discriminating in favor of its own production or storage."

Industry spokesmen greeted the Rinehart measure with the same argument used earlier toward higher legal allowables: "You can't legislate markets. When the storage is full, where is the oil going?" They warn proration by the Corporation Commission or by the purchaser will result.

Other bills before the legislature are all minor. They concern plugging of abandoned wells to protect water sands, plugging seismic or core holes, authorizing the Corporation Commission to control pollution of streams by oil waste or salt water, and forcing gas producers to furnish farmers fuel to operate irrigation pumps.

The legislature took a 6-day recess from March 30 to April 6 because of a state-wide election on a school-finance constitutional amendment. The oil bills will get further consideration when the lawmakers return.

Big Flood Ready

Sholem Alechem recovery program wins approval

TULSA.—Plans have been set in motion by Stanolind Oil & Gas Co. to waterflood a 2,440-acre segment of Sholem Alechem field in southern Oklahoma.

The green light was given the unitization and secondary recovery program last week when the Oklahoma Corporation Commission ordered the field unitized after years of planning and negotiations.

Involved is Fault Block "A" of the Sims sand of the northwest end of the field. Stanolind, as operator, is preparing to install water-flood equipment, operate the flood and the 244 wells in the unit.

Big payoff . . . Stanolind said the secondary recovery program is expected to step up future oil recovery from 3,700,000 bbl. to 52,330,000 bbl. and extend the life of the field to 1977.

Cumulative recovery from Fault Block "A" on January 1, 1955, was 25,970,000 bbl. of oil with total estimated recovery under primary methods only 29,670,000 bbl. Under water flooding the total estimated recovery is 78,300,000 bbl.

Participating in the program will be 40 operating oil companies. Largest are Stanolind, Amerada Petroleum Corp., Atlantic Refining Co., Champlin Refining Co., Magnolia Petroleum Co., and Sun Oil Co. A total of 291 separate royalty interest owners joined the unitization plan.

The Sims sand production was opened in Sholem Alechem by Stanolind in August 1947. It was the first Springer production in this field which had produced for a number of years in shallower formation.

Discovery Going Deeper

Reagan production is sought in southern Oklahoma test which brought big lease play after opening Viola field

By Carl Hoot

ARDMORE, Okla. — A key test in southern Oklahoma which opened a thick Viola pay zone and touched off a hot lease play is now looking for deeper production.

Oil companies are closely following the drilling progress at Frankfort Oil Co. 2 Williams, pre-Cambrian test in the Lone Grove district in Carter County.

The well is now below 11,825 ft., after uncovering a prolific Viola limestone reservoir at 5,100 ft. Plans call for testing the Reagan sand (equivalent to Hickory sand of Cambrian age in West Central Texas), but Frankfort must drill a complete Arbuckle section to reach this zone.

Geologists estimate the Arbuckle limestone may be from 6,000 to 7,000 ft. thick. The well already has cut more than 5,000 ft. of this formation.

Few wells in southern Oklahoma have cut an entire Arbuckle section; it is known that porous dolomitic zones occur in the lower part of the Arbuckle. To date, few operators have had the fortitude, or the cash, to check the oil possibilities of the potential pays.

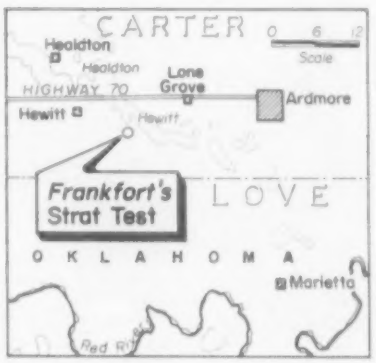
Leasing . . . Frankfort has more than 22,000 acres surrounding the well. Viola production in 2 Williams kicked off the usual lease play. Acreage prices rose from $25 to $250 per acre. The buying trend now covers a narrow belt 30 miles long.

Development . . . Frankfort has completed seven wells in the Viola. When Frankfort's 2 Williams logged a 900-ft. pay section, an offset, the 3 Williams, was drilled and completed as the first Viola producer in the area.

In the seven completed wells, pay section has ranged from 700 to 1,100 ft. in thickness, at an average depth of 5,500 ft. Potentials through 14/64-in. choke have been approximately 50 bbl. of oil an hour. Drill-stem tests in all wells were discouraging, but the limestone reacted to acid treatment, and all wells have held their initial producing rate.

The thick sections of Viola in Frankfort's wells is normal throughout most of the Marietta basin. In other areas of Oklahoma, the Viola may average no more than 300 ft. thick.

Deep test . . . Frankfort 2 Williams has a heavy-duty rig in operation. It



is being drilled as a stratigraphic test, with no definite contract depth. Location is in an area that has been a big quesion mark to geologists and producers alike. The area is known to be made up of complicated folded and faulted structures, and it is thought to offer good potentialities.

PARKER DRILLING CO. rig on location.

At 11,600 ft. 2 Williams had penetrated more than 5,000 ft. of Arbuckle rock. Operators reported the well to be drilling through a "gentle" dip of 30°, and they are confident of reaching the Reagan. Only one well, near Comanche in Stephens County, produces from the Reagan in Oklahoma.

Frankfort's well was located on subsurface geology. Some control was offered by a dry hole drilled by Sinclair Oil & Gas Co. about 5 miles to the southwest. This well logged a 1,100-ft. Viola section.

Frankfort is the sole operator on the deep test and is drilling without dry-hole money. Other companies holding leases in the area include Inland Oil Co. and Sun Drilling Co.

ROCKY MOUNTAIN

Oil Tax Believed Certain

DENVER.—Republican leaders of the Colorado Legislature predict an oil and gas production tax will be passed during the current session.

Republicans generally favor a House-approved bill pending in the Senate. It provides rates and credits substantially the same as those in the present law enacted in 1953. A graduated tax is levied on gross income of operators and is producing about $2,500,000 annually. However, it is being paid under protest by some companies who claim the tax is illegal and discriminatory.

GOP sponsors plan to pass the new proposal on preliminary reading in the Senate, then ask the Colorado Supreme Court to rule on its constitutionality. The legislature would be held in temporary adjournment for 60 to 90 days awaiting the decision.

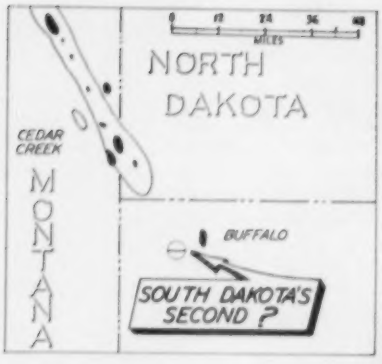
If the court rules the tax legal, the Senate would pass the bill. If not, the Republicans have prepared a constitutional amendment for the 1956 election ballot to permit voters to place the tax in the state's basic law.

Butte Pipeline Surveyed

GUERNSEY, Wyo.—Aerial and ground surveys are under way for the 16-in. crude-oil pipeline to be built from northeastern Montana to southern Wyoming by Shell Oil Co. and Murphy Corp.

Construction will begin this summer after the route is plotted. Completion target date is September. The 450-mile line will extend from Montana's Poplar field in Roosevelt County to Guernsey, where it will tie into existing lines serving eastern markets.

Shell and Murphy have formed Butte Pipe Line Co. to operate the line.



New Field Looms

Shell-Carter test gives South Dakota second play

RAPID CITY, S. D.—A second oil field is in prospect for South Dakota at a joint wildcat of Shell Oil Co. and Carter Oil Co. located 8 miles southwest of Buffalo field, the state's only producing oil pool.

The prospective discovery, 1 Hansen and Clarkson, NE NE 28-21n-3e, recovered 92 ft. of gas-cut muddy oil, 60 per cent oil, and 273 ft. of gassy, oily mud, 25 per cent oil. The drill-stem test was taken at 8,260-8,341 ft. in the upper Red River (Ordovician).

Shell has two producing wells in the Buffalo field with Red River production at about 8,600 ft. The Shell-Carter well is in line with the southeast end of the Cedar Creek anticline in Montana and North Dakota.

Gas-Import Plan Approved

BUTTE, Mont. — Montana Power Co. is a step nearer to importing more natural gas from Canada.

The Butte company has received permission from Federal Power Commission Examiner Richard N. Ivins to import up to 100 million cubic feet daily, not to exceed 20 billion cubic feet annually.

The decision is subject to review by the FPC. However, if the commission doesn't act within 30 days, it becomes final. The commission granted Montana Power authority in 1952 to import up to 40 million cubic feet daily and a maximum of 10 billion cubic feet annually until April 7, 1956.

Examiner Ivins dismissed protests of coal interests by pointing out that no damage to public interest would result from augmenting Montana Power's present supply of natural gas. The firm will use the gas to extend service to 11 towns and to increase supply to present customers.

WEST COAST

Wells just keep sprouting from . . .

. . . Huntington Beach Town Lots

LOS ANGELES.—The Jones sand pool being developed on the southern edge of Huntington Beach may capture the unenviable record of being among the most over-developed areas in California.

The number of producing wells last week passed the 100-mark. All were producing from a pool which in the townlot area extends over less than 60 acres. How much of the pool underlies the nearby Pacific Ocean is undetermined.

Observers expect another 80 or 100 wells will be added to the field before drilling halts. By then the 3,900-ft. sand, which averages 100 ft. thick, will have been drilled to a density of about one well per 0.3 acre.

Drilling still shows only little sign of subsiding. About 45 rigs were still at work last week but weekly locations have slipped from the February high.

The development is occurring under townlot conditions and even the lots are small. Nearly all are 25 ft. wide and less than 125 ft. deep. Some lots contain one, even two wells. Smallest property to be drilled is a 25 by 36-ft. area. It produced a 200-bbl. flowing well.

Close well spacing is having its effects on per-well production. On March 29, production from 98 wells totaled 9,800 bbl. daily. The 100-bbl. per well average represented a decline of 65 bbl. from the month previous. Highest output of any was 370 bbl. daily. Only four Jones wells also are still flowing.

The tendency for the weekly per-well production to level off has been masked by flush production of about 10 wells being completed weekly. Unquestionably the curve is flattening, however. Engineers familiar with the area predict a production peak in excess of 12,500 bbl.

Offshore Line Planned Soon

LONG BEACH.—Monterey Oil Co. plans to start construction soon on an 8-in. pipeline from Seal Beach to its drilling island 1½ miles offshore.

The line will have a capacity for transporting about 5,000 bbl. of crude and gas daily to shore-located separating and storage facilities. In addition, three 3-in. lines will be laid for carrying water and drilling mud to the island.

Monterey, as operator for the state-granted lease it holds jointly with The Texas Co., has completed three wells and is drilling a fourth from the earth-filled island, which is 75 ft. in diameter. It is believed likely that at least 10 more slant holes can be drilled before the structure will have to be enlarged.

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Iraq Hikes Oil Cash

Second Middle East nation eliminates price discount to oil firms and increases revenue from its crude

Dahl Duff

ANOTHER major Middle East oil-producing country has begun taking a bigger slice of revenue from its foreign-developed oil fields by eliminating the so-called offtaker discount.

The Iraq Government on March 24 signed an agreement in Baghdad with representatives of Iraq Petroleum Co., Ltd., changing their financial arrangements. The government's income, as a result, will increase this year to around $202 million.

Iraq thus joins Iran in dealing itself a bigger share of oil income.

The 50-50 oil concession agreements which came into force in the Middle East several years ago generally allowed owners of the concession-holding company to buy crude at a discount of about 32 cents below posted price. It is this actual sales revenue that, after deducting operating costs, is split between company and government.

In the agreement negotiated last summer between Iran and an eight-company consortium, the discount was replaced by a much smaller deduction of around 2 per cent off posted price. Since most concession contracts in the Middle East contain a "most favored nation" clause granting the best terms given elsewhere in the region, it has been only a question of time until the discount structure would fall elsewhere.

Because Iraq's fields are inland from tidewater tanker terminals, the government-company split is based on a theoretical price reflecting value at the country's borders. In case of Kirkuk oil, which is moved through long-distance lines to the Eastern Mediterranean, price at the Iraq-Syrian border was raised from the old discounted $1.73 to about $1.95 after taking off 2 per cent.

For 35°-gravity Zubair crude produced by I.P.C.'s associated Basrah Petroleum Co., Ltd., the old discounted price of $1.66 was increased to $1.86, also giving effect to the 2 per cent discount.

An Iraq Government statement said the new agreement amending the 1952 50-50 pact would raise the government's revenue by 12.9 cents a barrel. This indicated the previous average discount, less the 2 per cent, was around 26 cents. Dr. Madim Pachachi, economics minister who signed the agreement with Sir Herbert Todd, I.P.C. representative, predicted that Iraq's oil income in 3 years' time would rise to more than $280,000,000 a year with production at around a million barrels daily.

The Iraq agreement was retroactive through 1954, and for this year the government's revenue was increased by $29,400,000. Since it was previously announced that Iraq received $160,000,000 in 1954, this means a new total of $189,400,000. On the basis of an exported Iraq production of about 600,000 bbl. daily during the year, Iraq per barrel take in 1954 amounted to slightly less than 87 cents.

Whether elimination of most of the discount will be retroactive through 1953 is still being discussed between government and company. Dr. Pachachi said he hoped this question could be settled without going to arbitration.

Production increase . . . Announcement of the concession revision with Iraq was accompanied by disclosure that I.P.C. plans to increase its production and exports. A new deep-water port at Fao on the Shatt-el-Arab for shipping Zubair and Rumaila crude is under consideration. Plans also call for raising capacity of the pipeline system to the Eastern Mediterranean by about 120,000 bbl. daily.

A companion plan to divert the now-closed Haifa branch line may add another 120,000 bbl. daily and send the total capacity of the system to about 810,000 bbl. daily.

I.P.C. also is considering bringing a new field into production to supplement output of the important Kirkuk area. The field is Jambur, about 25 miles south of Kirkuk. Last June the company tested production on its discovery well at a reported rate of 17,000 bbl. daily from around 5,700 ft.

One particularly valuable aspect of the discovery is that the crude tested 40° gravity and is sweet. Most production in the Middle East ranges from 32° to 36° gravity.

I.P.C. expects to bring the new Jambur area into commercial production late this year. Two additional wells are being drilled in the field and a pipeline connection from Jambur to Kirkuk is planned.

Iraq's premier, Gen. Nuri es-Said, told the Iraq Senate that agreement on pipeline expansion to the Eastern Mediterranean has been reached between the government and the company.

Diversion of the Haifa branch north to a new outlet in Lebanon has been under consideration for some time, but the right-of-way with Syria has not yet been cleared.

The I.P.C. system from Kirkuk field in Iraq consists of 12 and 16-in. lines leading to Tripoli, Lebanon, and a 30-32-in. to Banias, Syria. The 12-in. and partially completed 16-in. to Haifa has been inoperative since 1948 because of the Arab-Israeli strife.

About 160,000 bbl. daily is run through the lines to Tripoli and another 375,000 bbl. daily to Banias. The Banias line was completed about 3 years ago using four pump stations. The planned additional throughput will be achieved by bringing this line on a six-station basis.

Others eye changes . . . Meanwhile other Middle East nations are looking at their concession agreements with an idea of revising their oil income upward.

Similar revisions of the concession agreement signed in 1951 in Kuwait have been reported under discussion. These talks were aimed at bringing terms of the Kuwait agreement in line with those granted by the consortium companies in Iran.

In Saudi Arabia, the removal of the offtaker discount has been under negotiations for many months. The discussions are reportedly complicated by various side issues, but it is expected that the discount question eventually will be settled on the new pattern.

B. P. Operates New Units

British Petroleum Co., Ltd. has completed and placed in operation the fourth and fifth of seven Platforming units built or on order at its refineries in the Eastern Hemisphere.

The newest such unit, having a capacity of 6,000 bbl. per stream day was commissioned at the Kent refinery on the Isle of Grain in England. Earlier, a Platformer of the same size was brought on stream at the Kwinana refinery in Western Australia.

A sixth Platformer is nearing completion at the Llandarcy refinery in South Wales, and foundations for a seventh are being laid at the Porto Marghera refinery near Venice, Italy. Other units are in operation at B.P. refineries at Aden; Lavera, France; and Hamburg, Germany.

Free World Output Rises

All-time record in U.S. crude-oil production accounts for entire increase in January; Middle East total drops

CRUDE-OIL production in the free world during January increased 357,600 bbl. daily over the December output as result of an all-time high in the United States.

Free world output reached 13,204,900 bbl. daily, despite a slight drop in total production of other non-Communist countries. Higher allowables in major oil-producing states brought crude production in this country to 6,761,000 bbl. daily in January, up 367,000 bbl.

Non-Communist foreign countries averaged 6,443,900 bbl. daily in January, down a negligible 9,400 bbl. daily. As compared to January 1954, average output in the free world outside the United States was up 784,200 bbl. daily, or 13.9 per cent.

Middle East drop . . . The principal drop in foreign production took place in the Middle East. Higher output in Iran was reflected in curtailment of production in Saudi Arabia, Iraq, Kuwait, and Qatar for the first time since the consortium took over last October. Total production in the Middle East amounted to 2,950,100 bbl. daily in January, 51,700 bbl. daily under December.

In Iran, production averaged 227,000 bbl. daily, which was 40,000 bbl. daily, or 21.4 per cent higher than in December. On the other hand, production in Iraq was off 13,800 bbl. daily for an output of 636,900 bbl. daily. Production in Saudi Arabia was down 70,300 bbl. to 914,500 bbl. Output in Kuwait was off 1,800 bbl. daily to 1,013,300 bbl. daily. Qatar production was down 6,100 bbl. daily.

Turkey, where oil production is insignificant in comparison with Persian Gulf countries, boosted output to 2,300 bbl. daily, an increase of 300 bbl. daily, or 15 per cent over December.

Italy up . . . Oil production in Italy rose 500 bbl. daily during January with the opening of Gulf's new field at Ragusa, Sicily. This brought total production in Italy to a record 2,500 bbl. daily. The remainder of the country's production comes from small government-owned fields in the Po Valley. In the Netherlands, crude output rose 1,200 bbl. daily for a record high of 19,700 bbl. daily, or 6.5 per cent over the December total. French crude output was estimated at 15,000 bbl. daily.

Output again fell in Egypt, where production has been on a downward trend for more than a year. The January average was 3,900 bbl. daily under the December figure. Total output for the country during January was 32,900 bbl. daily, down 10.6 per cent. Production in Ras Gharib field was off 1,000 bbl. daily; in Asl field, 2,600 bbl. daily; and in Ras Matarma field, 300 bbl. daily. Egypt's chief hope for increased production in the near future is in the Belayim and Feiran fields of Sinai Peninsula where the International Egyptian Oil Co. is concentrating on immediate development.

Venezuelan record . . . Other Western Hemisphere countries showed smaller increases than the United States during January. Canada's crude output was up 12,000 bbl. daily, or 3.9 per cent. Venezuelan production increased for the fifth month in a row. Output climbed by 28,100 bbl. daily to bring the average to a new all-time high of 2,111,000 bbl. daily.

Colombia's output rose above the 100,000-bbl. daily mark after slipping below this level in December for the first time in 2 years. Its average of 102,400 bbl. daily was an increase of 4,300 bbl. over December. In Ecuador, crude production rose for the fifth straight month, reaching a new record of 9,800 bbl. daily, a 6.5 per cent increase over December.

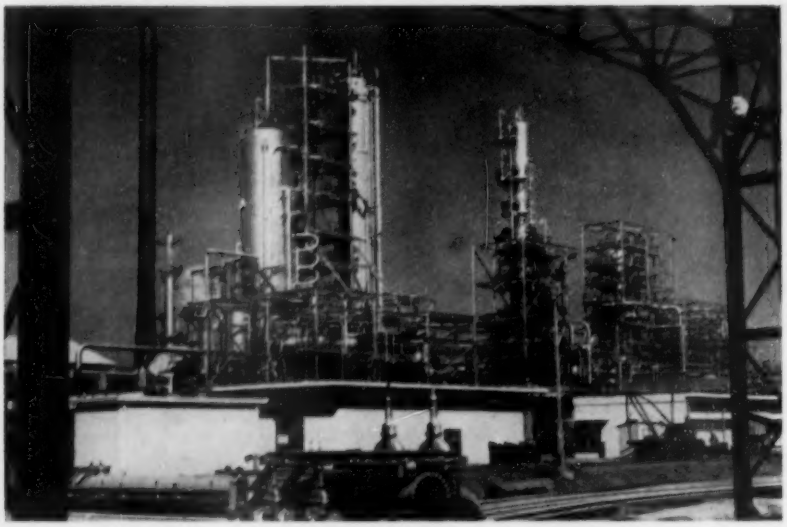
TREND OVER THE LAST YEAR

	Western Hemisphere less U. S.	Middle East	Non-Communist foreign
1954—			
January	2,713.2	2,487.6	5,659.7
February	2,703.7	2,550.6	5,695.3
March	2,642.9	2,767.6	5,872.7
April	2,565.1	2,642.0	5,653.1
May	2,639.3	2,766.0	5,863.8
June	2,648.5	2,685.0	5,805.5
July	2,667.0	2,758.7	5,890.9
August	2,663.7	2,749.5	5,891.9
September	2,704.5	2,702.2	5,879.2
October	2,750.0	2,898.6	6,141.6
November	2,856.7	2,844.6	6,193.6
December	2,957.7	3,001.8	6,453.3
1955—			
January	3,000.1	2,950.1	6,443.9

CRUDE-OIL PRODUCTION
(Daily average in thousands of barrels)

Country—	Jan. 1955	Dec. 1954	Jan. 1954
W. Hemisphere:			
Argentina	92.0	92.1	80.5
Bolivia	6.4	6.2	3.4
Brazil	4.5	4.3	2.2
Canada	318.0	306.0	258.5
Chile	6.0	6.0	4.5
Colombia	102.4	98.1	113.4
Cuba	0.3	0.4	0.1
Ecuador	9.8	9.2	8.2
Mexico	235.0	237.5	225.0
Peru	47.0	47.3	46.1
Trinidad	67.3	67.3	63.4
Venezuela	2,111.4	2,083.3	1,907.9
Total	3,000.1	2,957.7	2,713.2
W. Europe and Africa:			
Algeria	1.4	1.4	1.6
France	15.0	13.0	7.2
Fr. Morocco	2.2	2.2	2.3
W. Germany	55.4	55.3	46.0
Italy	2.5	2.0	1.6
Netherlands	19.7	18.5	17.1
Egypt	32.9	36.8	36.2
United Kingdom	1.2	1.2	1.2
Total	130.3	130.4	113.2
Middle East:			
Bahrain	30.1	30.1	29.9
Iran	227.0	187.0	33.0
Iraq	636.9	650.7	586.9
Kuwait	1,013.3	1,015.1	792.0
Neutral Zone	24.0	24.0	14.3
Qatar	102.0	108.1	96.1
Saudi Arabia	914.5	984.8	934.7
Turkey	2.3	2.0	0.7
Total	2,950.1	3,001.8	2,487.6
British Borneo	99.0	99.0	102.0
Burma	3.7	3.7	3.5
India	7.0	7.0	7.0
Indonesia	230.0	230.0	217.2
Japan	5.9	6.0	6.0
New Guinea	12.5	12.4	4.8
Pakistan	5.3	5.3	5.2
Total	363.4	363.4	345.7
Total non-Communist foreign	6,443.9	6,453.3	5,659.7
United States	6,761.0	6,394.0	6,240.4
Total, Free World	13,204.9	12,847.3	11,900.1
Communist controlled countries:			
Russian Zone of Austria	57.5	57.5	62.0
Romania	125.0	125.0	110.0
Russia	1,210.0	1,210.0	1,085.0
Others	36.8	36.8	33.9
Total	1,429.3	1,429.3	1,290.9
World total	14,634.2	14,276.6	13,191.0

Figures are from reliable reports in the industry or official government sources. Data for Russia and Eastern Europe are based on competent estimates; no authentic information is available on month-to-month production in these areas. Estimates also have been made for other countries, particularly in Southeast Asia, where completely current reports are lacking. Other Communist includes China and Yugoslavia as well as the Soviet satellite countries in Europe.



Burmah-Shell plant boosts . . .

. . . India Near Big Refinery Goal

A PROGRAM making India largely self-sufficient for its major needs of petroleum products neared realization with the opening of the new 40,000 bbl. daily Burmah-Shell refinery at Bombay.

The refinery was formally dedicated in mid-March in ceremonies attended by high government and company officials. They included Dr. S. Radhakrishnan, vice president of India; Sir Kenneth Harper, chairman of Burmah Oil Co., Ltd.; and F. A. C. Guepin, a managing director of the Royal Dutch-Shell Group.

The Burmah-Shell refinery is the largest thus far built in India *(The Oil and Gas Journal, February 21, page 104)*. Three and one-half years ago nationalization policies in Iran and closing of the Abadan refinery, formerly a major supply source for India, touched off plans for new refineries by the three principal marketing companies, Burmah-Shell, Standard-Vacuum, and Caltex.

Before this, the only refinery in India was the 7,000 bbl. daily plant of Assam Oil Co., Ltd. (a subsidiary of B.O.C.) which processes the country's domestic production in the northeastern area. Standard-Vacuum's new 25,000 bbl. daily refinery, also at Bombay, was finished last summer.

The third new refinery in the program is the Caltex plant at Vishakapatnam on which work is just beginning. Caltex recently received government approval to raise capacity of the project from the originally planned 10,000 bbl. daily to 13,500 bbl. daily.

The Burmah-Shell refinery, built by the subsidiary Burmah-Shell Refineries, Ltd., at a cost of more than $64,000,000, is situated on a 450-acre site on Trombay Island 10 miles northeast of Bombay. Process units include catalytic cracking and facilities to manufacture asphalt.

Concession Debated

Italian discovery shut in pending ruling on permit

ITALY'S 28-year-old oil law faces a major test in the application for an exploitation concession in the Pescara area.

The application is being studied by the Higher Mines Council of the Italian Government in Rome. A decision on whether the concession will be granted is expected soon.

Petrosud, S.A., the jointly owned company of Gulf Oil Corp. and Montecatina Chemical Co., is seeking the permit. The company recently completed the only important oil discovery thus far made on the Italian mainland *(The Oil and Gas Journal, February 14, page 92)*. The well, Cigno 1, located on the Adriatic coast across the peninsula from Rome, tested about 2,000 bbl. daily of 34°-gravity crude. The well is shut in pending action on the concession bid.

Under the old Italian mining code, the government can refuse production rights even after a discovery is made. Oil laws of most countries allow an almost automatic privilege of converting exploration acreage to the production phase.

Government circles in Rome anticipate, however, that the council will approve the concession. Current Italian policy stresses mineral resources development, and amendments to the oil law to encourage foreign capital are being studied by a Chamber of Deputies commission.

Brazil Expanding

Refinery will serve new asphalt, styrene plants

BRAZIL'S important 50,000-bbl. refinery at Cubatao, near Santos, will be expanded to include a new asphalt plant and a nearby styrene-monomer plant.

The new asphalt plant will be designed and built by Southwestern Engineering Co., Los Angeles. It will produce 116,000 tons of asphalt yearly. That will be enough to make Brazil self-sufficient for the material despite an extensive road-building program.

The plant will have an input capacity of 3,500 bbl. daily of heavy crude oil, to be supplied from Western Venezuela by Standard Oil Co. of California and its subsidiary, Richmond Exploration Co.

California Standard, in cooperation with the Brazilian Government organization, Petrobras, will be technical advisor during the designing and erection. The project is scheduled for completion this November.

Two United States companies will join Brazilian interests in building and operating the styrene plant next door to the refinery. The plant, capable of producing 10 million pounds a year, will supply the Brazilian domestic plastics industry.

U.S. firms participating are Koppers Co., Inc., and Firestone Tire & Rubber Co. The group is organized as Companhia Braziliera de Estireno.

Firm to Use New Process

A Dutch company is expanding its output of nitrogen fertilizers with a new process based on use of crude oil.

The company, MEKOG, is planning to build a new plant at Velsen-Ymuiden and boost its annual production of fertilizers from 370,000 to 500,000 tons over the next few years. Cost will be around $9,000,000.

The company said it would be the first to use the new process. Costs are lower than with coal, but the company said, existing plants producing ammonia based on hydrogen from coke-furnace gas process will continue to operate.

Argentine Oil Grants Approved

Peron says agreement reached on exploration permits; they would be first new grants in country since 1934

THREE international oil companies may be about ready to undertake exploration and development in long-closed Argentina.

This was the gist of reports from Buenos Aires last week. President Peron told a group of Argentine congressmen that the government had succeeded in coming to terms with the companies.

He did not identify the companies, but it is known that Standard Oil Co. of California, Standard Oil Co. (N. J.), and Royal Dutch-Shell, plus Floyd Odlum's Atlas Corp., submitted proposals to the Argentine Government last year.

If these deals go through, it will be the first time in 21 years that Argentina has granted new acreage to foreign operators. The Argentine Government well over a year ago indicated it was interested in attracting foreign oil capital back into the country.

Capital scarce . . . Peron's government has recognized that the state company, Yacimientos Petroliferos Fiscales, lacks the resources and capital needed to develop production to meet the country's soaring oil requirements.

In San Francisco, Standard of California said it had had no word from Buenos Aires that the contract had been signed. A Jersey Standard official said that the company's contract had not been signed but that the negotiations seemed to be approaching conclusion on an acceptable basis.

Jersey Standard and Shell have small and dwindling crude production in Argentina from wholly owned concessions obtained before 1934. Standard of California is not now in the country. Atlas last summer made a proposal to Argentina for oil development in the Neuquen area along with plans for uranium mining and construction of a pipeline to the coast.

Peron "satisfied" . . . President Peron said the oil companies are "going to take the oil out for us, not for themselves." There has been "no surrender of any kind," he declared, and constitutional provisions reserving mineral rights to the state have been fulfilled.

"I am very satisfied with these agreements, and let it be said that I am not very easily satisfied with foreign oil companies," he told his legislators.

Final terms of whatever agreements are signed will be of top interest. The fact that concession-granting governments have legal title to their oil has long been recognized and was made ever more plain in the Iranian agreement last summer. In exploration deals abroad, the larger foreign oil companies have stood on the minimum conditions of at least 51 per cent interest and basic rights of management.

Iran Finds Buyer

Japanese firm involved in oil, ship, plant deal

IRAN'S government oil company is working out a deal to make long-term crude sales to the Japanese firm that bought oil from Iran during the nationalization dispute.

The Japanese company is Idemitsu Kosan. Prior to the settlement between Iran and the eight-company international consortium last October, Idemitsu and two small Italian firms were the only companies buying oil from Iran in the face of British warnings of legal claim to the properties and production.

Idemitsu said in Tokyo it would build an 18,000-bbl. daily refinery if its application to the Japanese Government to buy the former Japanese Navy fuel arsenal in Tokuyama, Shikoku, was approved.

Iran's National Iranian Oil Co. would lend part of the estimated $12,600,000 cost of the project.

A promise of Iranian tankers to haul Iran's share of its oil production was made to several thousand workers at the Abadan refinery by the country's monarch, Shah Mohammed Riza Pahlevi. Addressing the workers during a tour of the installations, the shah said Iranian oil would be exported to world markets in Iranian vessels in the near future.

The agreement with the consortium gives N.I.O.C. an eighth of the production which it can sell on world markets or turn back to the companies.

Arbiters In Geneva

Onassis shipping contract with Saudi Arabia probed

ARBITRATION is under way in Geneva to determine whether A. S. Onassis' controversial shipping contract with the Saudi Arabian Government violates the concession agreement of Arabian American Oil Co.

Aramco has named as its arbitrator Saba Habashi, former Egyptian official who has been the company's consulting legal adviser. The Saudi Arabian Government earlier designated Dr. Helmy Bahjat Badawi, former Egyptian minister of foreign affairs, as its representative.

The two are in Geneva attempting to agree on a third, neutral member of the panel. Aramco's concession agreement providing the arbitration method of settling company-government disputes allows the president of the World Court to name a third member if the two representatives are unable to agree.

Onassis, one of the world's largest independent ship operators, raised a furore in petroleum industry and government circles when it became known about a year ago that he had negotiated a deal with Saudi Arabia giving him certain preference rights for movement of oil out of Saudi Arabia.

Another phase of the Onassis contract was under investigation in a French court in Paris. Hearings opened on a breach of contract suit filed by Spiridon Catapodis against Onassis. Catapodis alleges Onassis backed out on a promise to pay him a large sum for negotiating the Saudi Arabian contract.

Catapodis' charges add up to a story of intrigue and mystery. He claims that Onassis signed a contract with him in disappearing ink. Onassis said he understood Catapodis was acting for Saudi Arabia in the negotiations, but Catapodis countered with a claim Onassis had paid him a commission as his representative in a previous deal with Iraq.

International Briefs

A new tanker that will carry crude from Kuwait to Philadelphia for Cities Service Oil Co. has completed its maiden voyage to the United States. Operated by Comita Line, the 32,000-ton vessel is the largest ever built in Sweden.

Union Oil Co. of California has abandoned the first well in its exploration program in Costa Rica. The test, Patino 1, located in the southern part of Limon Province on the Atlantic side of the country, was taken to 6,754 ft. The rig, a National 75 owned by Loffland Brothers, has been moved to start Patino 2. Patino 1 was spudded October 21 as the first of a three-well program.

Anglo-Egyptian Oilfields, Ltd. (Royal Dutch-Shell) has made a northern extension to Ras Gharib field on the east shore of the Gulf of Suez. The well tested at a flowing rate of 650 bbl. daily at 2,270 ft. from an area not previously productive.

Beginning

Exploration in 1955

OIL IN THE BANK

. . . a look at and appraisal of active undeveloped

PETROLEUM PROVINCES . . . *in United States and Canada*

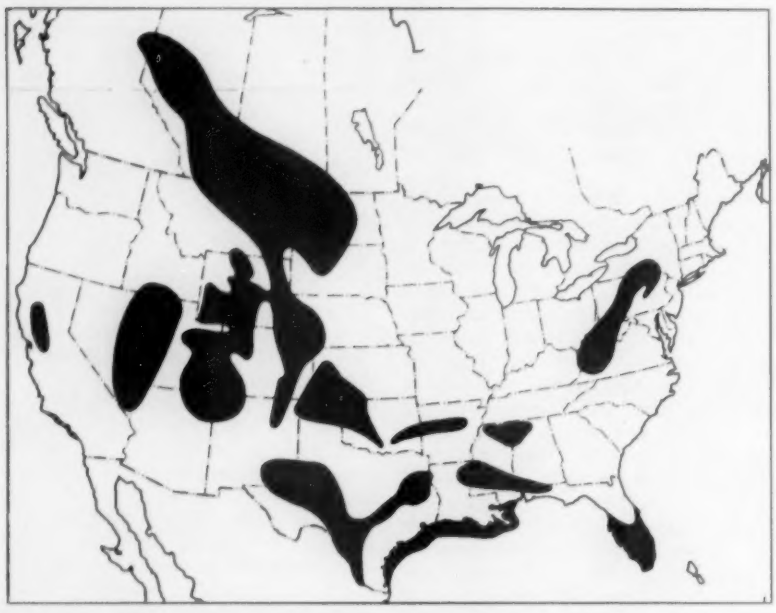


Fig. 1—The black areas locate undeveloped petroleum provinces which recently have had exploratory developments of especial significance.

by Philip C. Ingalls

THERE are today a number of large areas in North America recognized as offering possible oil and gas-bearing rocks which have not been sufficiently tested to establish their producing capabilities.

In some areas, these inadequately tested rocks constitute the entire stratigraphic section; in others, they are only the older strata of a sedimentary unit whose younger rocks are densely perforated and yielding oil.

In this discussion, these sparsely tested, potentially productive volumes of rock are called "undeveloped petroleum provinces." They are analogous, in some areas, to an unproved prospect; and, in others, to a possible deeper pool in a producing field.

This article is about some of the recent exploratory wells in the more active undeveloped petroleum provinces. It deals chiefly with these new-field and deeper-pool discoveries of 1954 which indicate certain of these undeveloped provinces may become significant producers of oil or gas somewhere down the road.

Established petroleum provinces, such as the Tertiary sediments of the Gulf Coast onshore area, the Upper Cretaceous-Woodbine of East Texas basin, the Permian rocks of the South Permian basin, the Paleozoics of the Mid-Continent region, and the deep Tertiary basins of California, will contiue to provide the bulk of domestic production for many more years. This paper is concerned not with such provinces, which expect numerous and often sizable discoveries, but rather with those provinces where a show of oil or gas may be extremely significant, and where a big discovery might have far-reaching effects on North America's oil industry.

The black areas in Fig. 1 locate undeveloped petroleum provinces which recently have had exploratory developments of especial significance. The recognized potentialities of these black areas vary greatly. For example: The Gulf Coast offshore is looked upon as a proved area—one that is known to harbor tremendous reserves of oil and gas; on the other hand, the Great basin of Nevada and Utah is an area about which too little is known to chance any forecast of its ultimate significance at this time.

Two big oil-producing areas, the East Texas basin and the South Permian basin, are included as undeveloped petroleum provinces because they are undergoing exploratory drilling of formations considerably older than those from which the bulk of the basins' oil is produced.

Now let's take a closer look at some of the black areas of Fig. 1 to see what significant exploratory developments they had during 1954 to make them attractive for additional wildcat drilling.

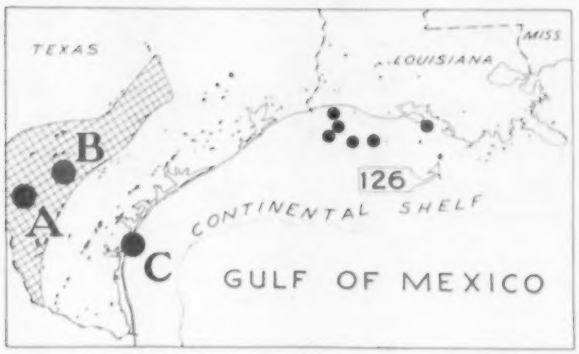


Fig. 2—Here's the undeveloped province that appears most likely to develop into a big producer.

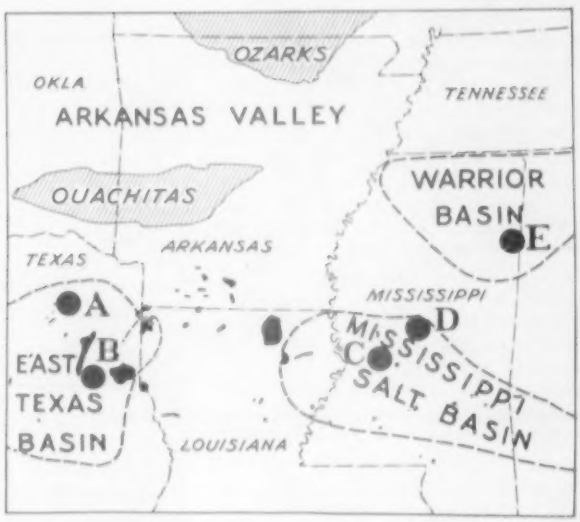


Fig. 3—To the north of the area shown in Fig. 1 are the basins of East Texas and Mississippi.

Gulf of Mexico

The undeveloped province that appears most likely to be the first to develop into a big producer of oil and gas is that beneath the shallow waters of the Gulf of Mexico off the coasts of Louisiana and Texas. (See Fig. 2.)

The Gulf Coast offshore offers a 25,000-sq.-mile-or-more extension of one of North America's greatest producing provinces. There is now little doubt that reserves of oil and gas underlying the submerged lands will equal or exceed those underlying adjacent onshore land of comparable area; and that, with sound leasing arrangements, they can be developed profitably despite operational problems unknown on land.

Offshore Texas got its first commercial oil discovery in June 1954. A wildcat at "C," which was drilled from a platform located about 1½ miles off Kleberg County, flowed 350 bbl. of oil per day from Frio perforations near 7,760 ft. At the end of the year this field, called Chevron, had two oil wells and one shut-in gas well. About 9½ miles south of the Chevron discovery well, another offshore discovery was made last year. A wildcat drilled out under the gulf from a location on Padre Island was completed in the Marginulina for an open-flow potential of 9.3 million cubic feet of gas and a small amount of distillate per day.

Six new-field discoveries were made in the open waters of the gulf off Louisiana last year. As shown in Fig. 2, five of these discoveries are grouped in the hitherto-productionless western portion of Louisiana's offshore area, one of which is located more than 25 miles from the coastline (as recognized by the federal Government.

In addition to the new-field discoveries, a number of new reservoirs were found in established fields offshore Louisiana. The most significant find was made by a well on the northwest flank of a large piercement-type salt dome at the 30-mile-from-shore Eugene Island Block 126 field. This well found several zones of Miocene oil sands with a total effective net pay of more than 700 ft. No longer is there any speculation that the thick, juicy sands of onshore area might not extend so far out.

In the left portion of Fig. 2, the cross-hatched area locates the downdip Mesozoic province of South Texas. Here Cretaceous and Jurassic rocks may someday be important producers of oil and gas. Interest in this province has been stimulated by two recent Lower Cretaceous-Edwards discoveries. In La-Salle County, a well at "A" flowed 3.5 million cubic feet of gas per day through a small choke to establish the southernmost Lower Cretaceous production in Texas Late in 1953, in McMullen County, the well at "B" tested an estimated open-flow potential of 70 million cubic feet of gas and 1,000 bbl. of distillate per day to extend Edwards production a dozen or so miles downdip toward the coast.

East Texas and Mississippi

On to the north, beyond the developed areas of the Upper Gulf Coast of Texas and South Louisiana, lie the basins of East Texas and Mississippi. (See Fig. 3). These are the East Texas basin, Mississippi Salt basin, and the Warrior basin.

Within the East Texas basin is the biggest oil field yet discovered in North America. East Texas field and other Upper Cretaceous-Woodbine fields of the East Texas basin have accounted for nearly 25 per cent of all of the oil produced to date in the State of Texas, or more than 8 per cent of all of the oil produced in the entire United States. And, Neches-Woodbine field, discovered late in 1953, is apparently the biggest onshore discovery in the United States since the Pennsylvanian reefs of Scurry County, Texas, were opened. It's good for, perhaps, 100 million barrels of oil. But, despite this record, the East Texas basin qualifies as an undeveloped province because it is relatively untested below the Woodbine

Results of the past year's exploratory activity in the East Texas basin have shown that the inadequately tested Lower Cretaceous limestones and the Jurassic-Smackover may have great potentialities.

Two exploratory tests have been selected as indicators of what deeper drilling may turn up in the East Texas basin: The dot at "A" locates a deeper-pool test at New Hope field in Franklin

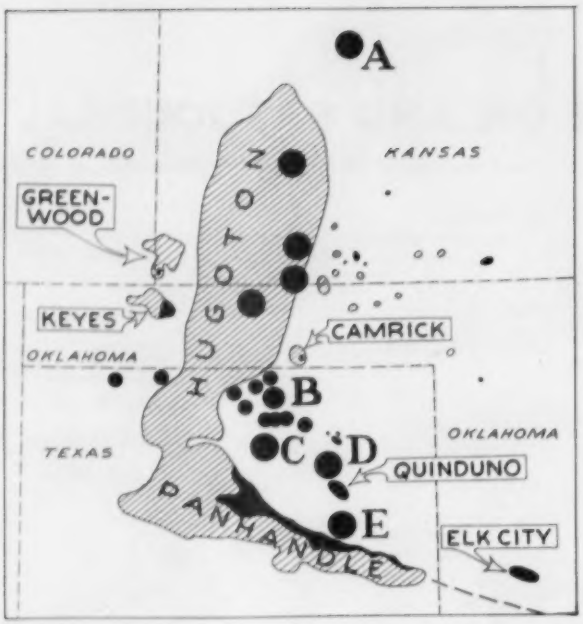


Fig. 4—The most active rank wildcat area in the United States is the northwest extension of the Anadarko basin.

Fig. 5—Exploratory drilling to the Permian basin's deeper rocks continue to turn up justification for optimism.

County. It was completed in the Smackover near 12,300 ft. for a calculated open-flow potential of 42 million cubic feet of gas per day with 170 bbl. of distillate and 6 tons of sulfur per million cubic feet of gas. On a small choke this well flowed more than 1,000 bbl. of distillate per day.

The well at "B," in Rusk County, was completed for an open-flow potential of 95 million cubic feet of gas per day plus some distillate from the Lower Cretaceous-lower Pettit, near 6,800 ft. This well had been drilled in 1944 and abandoned after testing salt water from the upper Pettit.

The Mississippi Interior Salt Dome basin cuts roughly east-west across southern Mississippi. Only a few significant oil fields have been found in this area and, prior to 1953, had no truly commercial production below the oldest Upper Cretaceous rocks.

The first important Lower Cretaceous production in Mississippi was found at Soso, one of the area's more important Upper Cretaceous gas-distillate fields.

Mississippi's second important Lower Cretaceous discovery was completed last August. This Hinds County well, at "C," found nearly 80 ft. of oil-saturated Paluxy sands and was completed flowing about 300 bbl. of oil per day through a small choke from 20 ft. of perforations near 9,900 ft. It caused a sudden revival of interest in many Central Mississippi prospects that had been abandoned after unsuccessful Upper Cretaceous tests.

On to the north in Madison County, at "D," is the wildcat which established the first Jurassic-Smackover production east of the Mississippi River. The discovery was made in 1953 but the well was not completed as a producer until last July when it flowed 240 bbl. of distillate and 5 million cubic feet of sour carbon-dioxide gas per day from open hole at 12,130-12,494 ft.

The Warrior basin of northeastern Mississippi and northwestern Alabama is composed of unmetamorphosed Paleozoics. Wells completed there during the past 3 years have proved sizable accumulations of gas and distillate; and one well, now abandoned, indicated that the basin may also yield oil in commercial quantities. Last year the area had one small Mississippian gas discovery, at "E".

Anadarko Basin

The most active rank wildcat area of the Central United States is the northwest extension of the Anadarko basin. (See Fig. 4.) Prior to 1952, essentially all oil and gas production within the region was from strata of lower Permian age in the more or less interconnected reservoirs of the combined Panhandle and Hugoton fields.

During the past 3 years, and especially during 1954, numerous discoveries of oil, gas-distillate, and gas reservoirs have been made in pre-Permian rocks of this area. Indications are that this province of northward converging Mississippian and Pennsylvanian rocks is going to provide oil and gas fields of truly significant proportions.

The largest pre-Permian gas field developed in the area to date is Greenwood, in Southwest Kansas. Drilling has proved up more than 100 sections of this stratigraphic accumulation in Pennsylvanian-Virgilian limestones near 3,400 ft.; and, it appears that the pool may ultimately at least double its present size. Completed wells in this field have had open-flow potentials averaging nearly 20 million cubic feet of gas per day.

Down in the Keyes area of the Oklahoma Panhandle, another pre-Permian oil and gas field is being developed with promising results. Production in this multipay area is principally from erratic Pennsylvanian-Morrow sands near 4,500 ft. About 100 sections can be considered proved for production in the combined areas of three merging fields where gas wells potential up to 55 mil-

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lion cubic feet per day and oil wells have flowed more than 300 bbl per day.

Four pre-Permian discoveries were made within the limits of Hugoton gas field last year. The northernmost well was a pumping oil well in the Mississippian-Chester. The next two to the south were sizable Pennsylvanian-Virgilian gas wells. The well in the Oklahoma Panhandle was completed as a small pumping oil well in the Pennsylvanian-Marmaton.

On the east side of Hugoton in the Oklahoma Panhandle is Camrick field. It is an area of Morrow oil and gas production which is expanding northwestward and has proved about 40 sections to date. The discovery well of the field was completed flowing about 200 bbl. of oil per day from perforations near 6,800 ft. A well in the northern extension area had a calculated open-flow potential of 150 million cubic feet of gas per day.

Northeast of Hugoton field, at "A," a wildcat was completed pumping 153 bbl. of oil per day from the Arbuckle near 5,000 ft. The nearest Arbuckle production at the time was 80 miles to the east near the western edge of the Central Kansas uplift. Soon afterwards, however, about 30 miles to the northeast, the second Arbuckle discovery for far-western Kansas was completed.

The small dots in the Texas Panhandle, on both sides of Hugoton field, mark the localities of more than a dozen pre-Permian discoveries made there during 1954. Though some oil was found, most of the discoveries were gas; and, except for one small Mississippian gas well, completions were in Pennsylvanian formations. Initial potentials of the Pennsylvanian gas wells ranged up to 25 million cubic feet per day. The one significant oil discovery, at "B," was completed in the Pennsylvanian-Atoka sand near 7,200 ft. for a restricted flow of 500 bbl. of oil per day. A confirmation test of the discovery flowed 1,300 bbl. per day, but a double offset was completed dry and abandoned.

Except for the gas at Quinduno oil field, the well at "C" was the first indicated Permian gas discovery in the Texas Panhandle since 1926. It flowed commercial quantities of gas from the white dolomite near 3,500 ft., but was completed dually in two Pennsylvanian formations for a combined initial potential of 16 million cubic feet of gas per day.

Subsequent to this indicated discovery, a wildcat in Roberts County, at "D," was completed for 11 million cubic feet of gas per day from the Permian-brown dolomite near 3,800 ft.

Recent developments in the Texas Panhandle which could prove to be most significant were two oil discoveries in the Pennsylvanian-granite wash along the north side of the Amarillo-Wichita uplift: One, a deeper-pool test of Quinduno field, was completed for 230 bbl. of 70° gravity distillate and 16 million cubic feet of gas daily; and the other, at "E," was a new-field discovery well which was completed flowing 260 bbl. of oil per day. The significance of these two discoveries becomes obvious when it is noted that Elk City field, 75 miles to the east, is a developed 100-million-barrel accumulation of oil and distillate in the same wedge of granite wash.

South Permian Basin

Development drilling in the South Permian basin of West Texas and Southeast New Mexico has not been abnormally high for nearly 2 years now, but exploratory drilling of the basin's deeper rocks continue to turn up proof that the optimistic predictions for the basin's future are warranted. (See Fig. 5).

On the shelf of Southeast New Mexico the basal Permian, Pennsylvanian, and Devonian rocks near and beneath the east-west trend of shallow Permian production have yielded positive indications of future fields of significance.

The four small dots at "A" locate recent discoveries which have indicated widespread gas-distillate sand zones and important oil pays in lower Pennsylvanian rocks.

From west to east, these discoveries were as follows:

1. A gas-distillate well completed for 30 million cubic feet of gas and 780 bbl. of distillate per day from about 10,000 ft.

2. A deeper-pool test of Premier field, which was completed flowing 287 bbl. of distillate and 7 million cubic feet of gas per day through 2-in. tubing from perforations near 11,000 ft.

3. A 12,000-ft. discovery in Grayburg-Jackson field completed flowing 196 bbl. of distillate and 4 million cubic feet of gas daily through 2-in. tubing.

4. A deeper-pool test of Maljamar field which was completed flowing 920 bbl. of oil per day through a small choke. This well was later plugged back for completion in basal Permian rocks from which it had flowed oil at rates of 30 bbl. per hour on drill-stem tests.

One of the deepest undeveloped petroleum provinces in the United States is the Delaware basin.

To date, essentially all of the small amount of production that has been developed in the Delaware basin has come from Permian-Delaware sands, but a few deep tests have indicated that the basin's producing future may be with the deeper Paleozoics.

Last March a wildcat on the northern edge of the basin, at "B," blew out near the top of the Pennsylvanian at about 12,600 ft. and caught fire. The well flowed an estimated 100 million cubic feet of gas and 200 bbl. of oil per day for 18 days without diminishing before being killed and later abandoned. A wildcat 1 mile to the north was completed last fall for an open-flow potential of 13 million cubic feet of gas per day, plus 140 bbl. of distillate and a little salt water, from the lower Wolfcamp near 12,600 ft.

Late last year, a well at "C" was completed for a calculated open-flow potential of 65 million cubic feet of gas per day from the Devonian near 12,700 ft.

A recently abandoned wildcat in Southwest Reeves County, at "D," exemplifies the great depths that may be required to reach the believed-to-be promising Devonian and Ellenburger rocks in the heart of the Delaware basin. At a total depth of 18,609 ft., this well was still in the Mississippian.

The Central Basin platform, which accounts for most of the Permian production in West Texas, has been sporadically yielding sizable pre-Permian fields for a number of years. Last year several more discoveries were made in the platform's relatively untested pre-Permian rocks. Outstanding was a deeper-pool test on the west side of the platform, at "E," in Winkler County. This well was completed for an open-flow potential of 160 million cubic feet of gas and 2,400 bbl. of distillate per day from the Ellenburger after drill-stem testing large gas flows from Devonian and Silurian rocks. This discovery is located more than 30 miles north of two 1953 Devonian discoveries, each of which had open-flow potentials of more than 100 million cubic feet of gas and 3,000 bbl. of distillate per day.

Along the east side of the platform in the Midland basin, between the two arrows, several high-initial-potential oil wells were completed as 13,000-ft. Ellenburger discoveries. These discoveries, proved the existence of sizable oil accumulations, and, together with the few deep oil fields in the area, have indicated the probability that there may be several long trends of potential Ellenburger and Pennsylvanian production roughly paralleling the grain of the platform.

One of the most promising portions of West Texas is that to the north of the Central Basin platform. Beneath the thick Permian sediments, which account for nearly all of the big producing fields of this area, there are some thick, exceptionally porous Devonian dolomites at about 12,000 ft.

Prior to 1954, these Devonian rocks

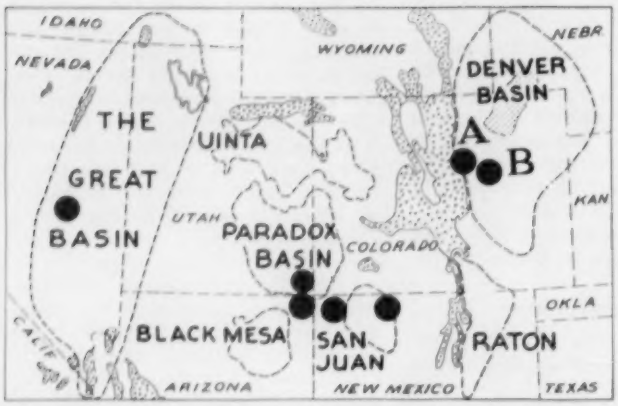

Fig. 6—Probably the most interesting single discovery in the United States during the past year was made by a Great basin wildcat.

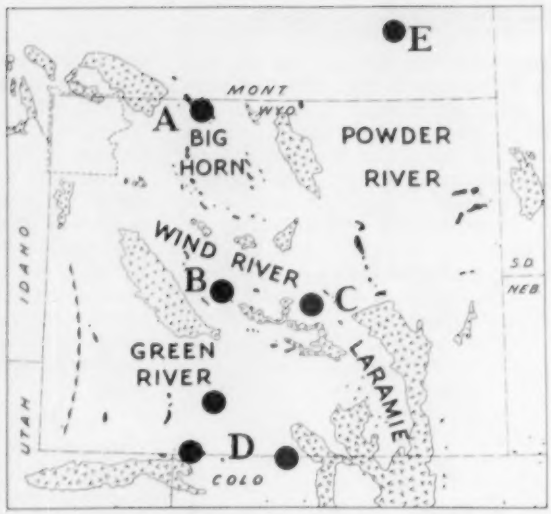

Fig. 7—A number of significant exploratory tests were completed in the intermontane basins of Wyoming during the past 12 months.

had yielded Denton and a few other fields in eastern Lea County, New Mexico, and just across the line into Texas; and a cluster of small fields in northeastern Andrews County in the southernmost extension of this area.

Last year two widely separated Devonian oil discoveries, at "F," and "G," materially strengthened the outlook for this area. Each was completed for a restricted flowing potential of more than 1,500 bbl. of oil per day.

The string of small dots on the east side of Fig. 5 locates a 50-mile-long trend of Cambrian production in Coke and Nolan counties on the eastern shelf of the Permian basin at about 6,000 ft. Cambrian oil in this area was found in June 1953, but the potentialities of Cambrian rocks were not generally recognized until early last year.

In addition to offering wells initialing up to 2,500 bbl. per day and recoveries in the neighborhood of 25,000 bbl. per acre, the development of Cambrian production is significant because the shallower Ellenburger had been considered the deepest objective throughout North-Central Texas where the Cambrian sands and dolomites are present.

The Southern Rockies

Probably the most interesting single discovery in the United States during the past year was made by a wildcat located in the Great basin. (See Fig. 6.) It was completed pumping 373 bbl. of oil per day from 300 ft. of fractured and vesicular volcanic rock of probable Tertiary age below 6,445 ft.; and, by the end of the year had averaged 250 bbl. of oil per day for 6 months.

This wildcat, drilled in a topographic and structural valley, was the first producing well in the little-known Great basin. Though its true significance cannot be evaluated with any degree of certainty, it has directed considerable interest toward an essentially untested province and its findings may be applicable to many of the long, narrow valleys which characterize the basin.

A few miles to the south and southwest of the discovery well, two wildcats were completed dry and abandoned. Neither well had a geologic section similar to the discovery well and they tend to confuse rather than clarify the subsurface picture. A fourth wildcat, located about 6 miles west of the discovery well, spudded at the beginning of 1955.

There were no exciting developments in the Uinta basin last year. The province's two small oil discoveries were made in Tertiary sediments already productive in the basin.

The Denver basin has Cretaceous, Permian, Jurassic, Triassic, Pennsylvanian, and Mississippian rocks; but, essentially all of the basin's production is from two sands in the Cretaceous-Dakota group.

Last year there were numerous small discoveries within the rapidly developing shaded portion of the basin, but, without exception, they were completed in Dakota sands.

All of the pre-Cretaceous rocks of the Denver basin and all of the Cretaceous rocks outside of the shaded area remain an undeveloped petroleum province.

Toward the end of 1954 there were two significant developments in this undeveloped province. In Elbert County, at "B," more than 30 miles southwest of production, a wildcat was being completed as a small pumping oil well from a Cretaceous sand near 7,200 ft. And, to the west, up against the Front Range of the Rockies in Jefferson County, a wildcat, at "A," drilled through a series of overthrusts after penetrating 1,000 ft. of the Pennsylvanian-Fountain formation to pick up the Cretaceous section again. On production tests, this well flowed more than 20 bbl. of oil per hour from a Benton-age limestone near 9,000 ft. It is not yet completed.

Petroleum-bearing rocks in the Four Corners area are found in the Paradox basin, the Black Mesa basin, the San Juan basin, and on the basinward flanks of associated uplifts. This entire area, except for the Upper Cretaceous rocks in the San Juan basin, is an undeveloped petroleum province.

Toward the end of 1954, a wildcat in the northeastern-most corner of Arizona was completed flowing about 2 million cubic feet of gas and a few barrels of distillate per day from the Pennsylvanian-Hermosa to become the first commercial discovery for the state.

Two significant exploratory tests were completed in the San Juan basin last year. The dot to the west locates a deeper-pool test in the small Hogback-Dakota oil field. The well was completed flowing 145 bbl. of 60°-gravity oil and 6.5 million cubic feet of gas daily through a small choke from the Pennsylvanian-Hermosa near 6,500 ft. The nearest Hermosa production is 25 miles to the northeast on the southern shelf of reefing limestones bordering the evaporite series of the Paradox basin.

The dot to the east is a wildcat located 20 miles east of the main gas-producing area in the San Juan basin. It was completed for 20 million cubic feet of gas per day from the Upper Cretaceous-Pictured Cliffs formation near 3,900 ft.

In the Paradox basin, near the southeasternmost corner of Utah, a wildcat was completed for a restricted flow of

214 bbl. of oil per day, no water, from the Pennsylvanian-Paradox near 5,300 ft. This well, which opened the first significant production in southeast Utah, has stimulated interest in the potentialities of the Pennsylvanian rocks across the southern end of the Paradox basin, especially along the zero line of the Paradox salt.

There is no hydrocarbon production in the Raton basin, but during 1954 there were several scientifically located wildcats drilled to test its potentialities. A wildcat in the New Mexico portion of the basin encountered small shows of oil in the Cretaceous-Dakota and one in the Colorado portion of the basin had a show of oil in the Pennsylvanian-Morrow.

Wyoming

A number of significant exploratory tests were completed in the intermontane basins of Wyoming during the past 12 months (See Fig. 7.)

The well at "A", on the Big Polecat structure in the Big Horn basin, may prove to be one of Wyoming's most important 1954 discoveries. This wildcat found more than 125 ft. of saturation in the Tensleep above 5,500 ft. and was completed for a pump potential of 470 bbl. of oil per day.

In the Wind River basin, at "B", a deeper-pool test at Beaver Creek field, Fremont County, was completed in the Mississippian-Madison for 340 bbl. of oil per day. Beaver Creek now has six producing formations ranging in age from Cretaceous to Mississippian. This field illustrates what may be in store for some of the Rockies' big producing structures untested at depth.

In a previously dry area in the eastern portion of the Wind River basin, a wildcat well, at "C", in Natrona County, was completed flowing more than 1,200 bbl. of oil per day from the Cretaceous-Muddy near 6,800 ft.

In the Green River basin, exploratory effort is directed primarily toward finding gas in lenticular Tertiary or Upper Cretaceous beds.

Several discoveries were made last year, the most significant of which were the three indicated near "D". All were Upper Cretaceous-Mesaverde discoveries with potentials ranging from 5 to 10 million cubic feet of gas per day.

Out in the middle of the previously dry Montana portion of the Powder River basin, at "E", a stratigraphic test was completed flowing 15 million cubic feet of gas per day from the Cretaceous-Eagle sand near 3,000 ft. This discovery is about 100 miles southwest and 100 miles northeast of the nearest previously established production.

Williston Basin

The most recent large sedimentary unit in North America to become a substantial producer of oil is the Williston basin. Production within the limits of this basin, as drawn in Fig. 8, is dominated by three areas: Poplar, Tioga, and Virden. Production at all three areas is entirely from Mississippian rocks. However, production tests in the Tioga area have proved commercial accumulations of Devonian and Silurian oil.

A number of fields on the Cedar Creek anticline produce oil from Siluro-Devonian and Ordovician rocks. Three of these fields are expected to develop into sizable producers once an adequate outlet is provided. A wildcat drilled well down on the east flank of this anticline found what appears to be a stratigraphically trapped accumulation of oil in the Ordovician-Red River near 9,200 ft. It was completed for 250 bbl. per day.

The dot at "A" locates a 1953 Ordovician discovery and a well 1½ miles away which was completed last year in the Mississippian-Madison for 136 bbl. of oil per day.

Near the southern end of the surface-expressed Nesson anticline, at "B", a well was completed early last year in the basal Mississippian sand for 550 bbl. of oil per day. All other production on the Nesson anticline is from the Madison.

The first commercial production of oil in North Dakota off the Nesson anticline was found in 1953 at Fryburg-Madison field, located by "C". Early last year the first Pennsylvanian production for the state was developed by a well in this small field. And, on a separate seismic structure about 5 miles to the northeast, the state's second Pennsylvanian producing well was completed for a pump potential of 200 bbl. per day.

South Dakota joined the list of producing states during 1954 with the official completion of a small Ordovician oil discovery, at "D", on the southeastern extension of the Cedar Creek anticline.

During 1954 the eastern portion of North Dakota witnessed an active search for oil in the regional wedge

Fig. 8—Production within the Williston basin is dominated by three areas: Poplar, Tioga, and Virden.

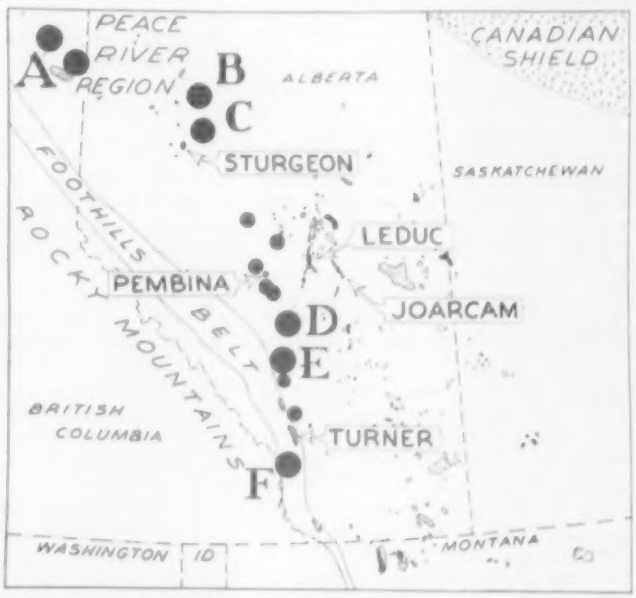

Fig. 9—It appears that Pembina is by far the biggest oil field discovered in North America during the past several years.

belts of porosity developed in the truncated, eastward-thinning Mississippian rocks. This activity was maintained throughout the year despite a steadily growing number of dry exploratory holes.

Several Mississippian oil wells have been completed in northern Bottineau County, North Dakota, at "G", but at the end of 1954 only three of these wells could be considered of commercial calibre.

There was a different story in the Canadian portion of the eastern flank of the Williston basin. Successes north of the border were a major factor in maintaining eastern North Dakota's essentially fruitless search.

The Virden area in Southwest Manitoba includes several expanding Mississippian oil fields, one of which yielded some wells which initialed more than 2,000 bbl. of oil per day. There has been enough drilling in this area, including successful wildcatting several miles in advance of development drilling, to indicate that this locality holds a sizable accumulation of oil—something on the order of 50 million barrels, perhaps.

In southeastern Saskatchewan, a Mississippian-Charles discovery well, at "E", was completed flowing 627 bbl. of oil per day. Followup wells were completed in the Mississippian-Mission Canyon.

Farther into the southeast corner of Saskatchewan, at "F", two 9-mile-apart Mississippian oil discoveries were completed toward the end of last year. One well flowed 150 bbl. per day through a small choke and the other had a pump potential of about 200 bbl. per day.

Western Canada

The oil industry in Western Canada as we know it today began in 1947. It was the discovery of Leduc field, followed by several other prolific Devonian reef fields nearby, that established western Canada as a promising petroleum province.

Initial exploratory activity in this new province was devoted primarily toward finding oil-saturated reefs. This search turned up a number of oil and gas fields in Cretaceous sands, but these sands were not generally recognized as outstanding objectives until late in 1953 when statigraphically trapped Upper Cretaceous-Cardium oil was found in the Pembina area. (See Fig 9.) Development of Pembina was at a virtual standstill last spring, summer, and fall because of rain; but the wells that were drilled extended the probable limits of Cardium production over an area of some 500 sq. miles and established a difference in elevation of the oil-bearing sand from the highest to the lowest well of more than 1,000 ft. It appears that this accumulation is by far the biggest oil field discovered in North America during the past several years. Reserve estimates range upwards of 800 million barrels.

In the same general area, production has been proved or indicated in pinchouts of three other Cretaceous sands. And, over to the east, at Joarcam, three Lower Cretaceous-Viking sand pools merged into one long field early last year to establish a stratigraphically trapped reserve of possibly 100 million barrels of oil.

Needless to say, sand reservoir occurrences, particularly of the broad stratigraphic variety, have become the objectives of an energetic search in western Canada.

The area of principal interest in this respect is that lying just to the east of the foothills on the east flank of the asymmetrical Alberta syncline. It extends from southern Alberta northward to the Peace River region and offers numerous Cretaceous sand pinchouts which set up traps capable of impounding large accumulations of oil and gas.

Peace River region . . . The Peace River region of British Columbia and Alberta has proved that it is a potentially great gas-producing area. Prior to 1954, gas had been found in rocks of Cretaceous, Jurassic, Triassic, and Permo-Pennsylvanian age. Last year, several sizable extensions were made to partially explored gas fields, but the most significant development in the area was the finding of oil by two 50-mile-apart wildcats.

The wildcat at "A" found 30 ft. of oil-saturated sand beneath 40 ft. of gas-saturated sand in a Lower Cretaceous or Upper Jurassic formation near 3,900 ft. On drill-stem tests of the gas zone the well flowed at rates up to 8.5 million cubic feet per day and a 1-hour test of a 10-ft. interval of the oil zone recovered 2,800 ft. of high-gravity oil.

The other wildcat is located to the southeast near the Alberta-British Columbia line. It flowed oil at a rate of about 5 bbl. per hour on a drill-stem test of a Triassic dolomite near 4,300 ft., but at the end of 1954 was drilling ahead to check the Mississippian.

Mississippian trend . . . The 200-mile-long string of small dots running north-south down the Alberta syncline locates the Mississippian oil and wet-gas discoveries of last year.

These discoveries, all of which lie west of the main area of Devonian production, resulted from an intensified interest in the potentialities of the deeper portion of the syncline following the discovery of Pembina field.

The wildcat at "D" opened up 146 ft. of gas-bearing Mississippian limestone betwen 8,700 and 8,851 ft. after flows on drill-stem tests for different intervals in this zone ranged up to 12.8 million cubic feet of wet gas per day. And, the well at "E" flowed oil at a restricted daily rate of 2,808 bbl. from 37 ft. of perforations in Mississippian limestone between 9,130 and 9,199 ft.

The dot just north of Turner Valley, Canada's only important field prior to the discovery of Leduc, locates a well which penetrated two porous zones of the Mississippian - Madison. On restricted flows, each zone yielded about 15 million cubic feet of gas and more than 100 bbl. of distillate per day.

A wildcat located 35 miles southwest of Turner Valley, at "F", drill-stem tested four Mississippian zones for a cumulative flow of some 50 million cubic feet of gas per day from the Madison between 7,210 and 8,155 ft. This well is the first and only commercial discovery within the folded and faulted foothills belt.

Devonian discoveries . . . No Devonian reef discoveries of established importance were made last year, but development drilling at Sturgeon Lake reef field, a 1952 discovery, has indicated a pool of at least 100 million barrels of oil.

There were two nonreef Devonian discoveries that may prove to have long-range significance:

At "B", a wildcat flowed 240 bbl. of oil per day from the pre-Woodbend Devonian-Beaverhill Lake formation. It is located about 3 miles from the only other well in Canada to find production in the same formation.

The wildcat at "C" recovered 1,500 ft. of oil on a 1-hour drill-stem test at 8,058-92 ft., of which the lowermost 5 ft. was in "granite wash" below Devonian-age strata.

This review has covered at least a few of the significant exploratory developments in the active undeveloped provinces of North America during 1954. Without question, wells that the future will prove to have been significant have not been mentioned; and likewise, wells that the future will prove to have had little or no significance have been included.

Acknowledgments

The author's thanks for assistance in preparing this summary go to his associates in Socony-Vacuum companies, especially to C. S. Corbett and E. A. Elliott for information on Canada, and, to A. MacRae for preparation of illustrations; to Phil D. Helmig, of Malco Refineries, Roswell, N. M.; and to Will Knight, of Union Producing Co., Jackson, Miss.

Where Is Tomorrow's Oil coming from?

Here's an "educated guess" as to where we'll be producing our oil in 1975-1980

by A. I. Levorsen

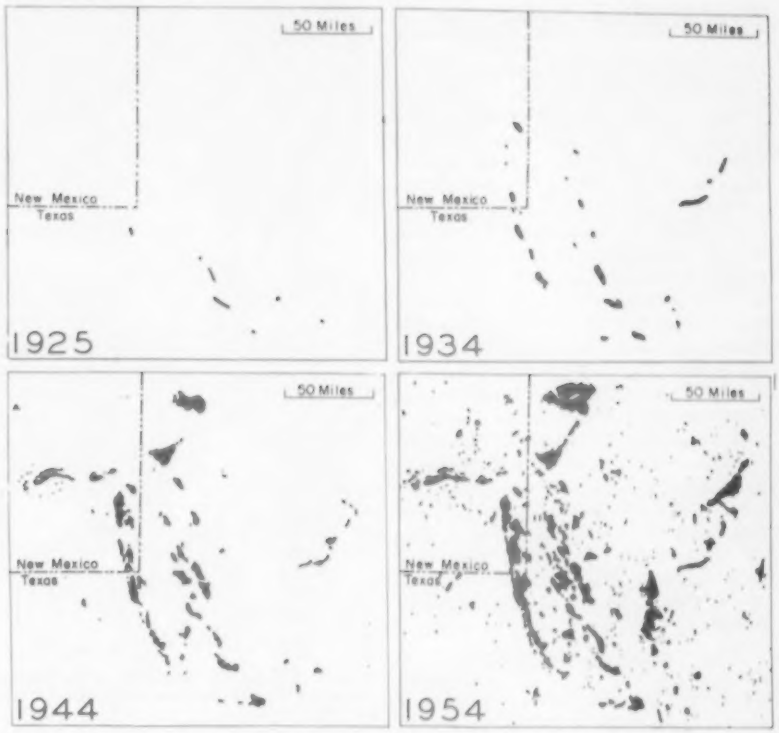

Fig. 1—Oil fields of Permian basin as they existed at 10-year intervals between 1924 and 1954.

WHEN we talk about the oil of the future, we are in effect talking about the future of the oil industry in the United States. Several surveys have arrived at the same conclusion—that we will be consuming twice as much oil 25 years from now as we do today—we will burn up the equivalent of an East Texas oil pool every year! The question is: "Do we have it?"

The oil in sight today in the United States will not begin to meet the needs of 1975-1980, unless, that is, we turn to automic power or to imports as our chief energy source. There is nothing new in this situation, as we have never had in sight more than a relatively few years' oil supply, and we have traditionally depended upon discoveries of new pools to meet our needs. But we are now faced with needs far greater than anyhing we have visualized heretofore, and both the industry and the nation continually examine its future prospects in terms of its needs—we should keep looking at our "hole card"—lest we wake up some morning with new laws and national policies that are based on lack of thought and on misinformation.

My views on our future undiscovered oil provinces are merely my own—they do not necessarily reflect the views of the geological profession or even of many members of it. I can see no deeper into the ground than anyone else. Nor can I foresee the future. And if I knew of some place where I could drill a well and discover a new pool, you may be sure I would be out there drilling. The geologist operates somewhat as the meteorologist—he visualizes conditions of tomorrow based on the evidence of today. He makes his prediction on the present evidence, but a new bit of information may change the prediction completely.

The province type . . . The word **province** is a loose but useful term that means a group of pools and fields producing under similar geological conditions. The Permian basin province is an example, and in this province there are many subprovinces, as the Midland basin subprovince, or the Central Platform subprovince. The salt-dome subprovince of the Gulf Coast province, or the heavy-oil province of Wyoming are other examples, and each conveys an idea of the kind of pools and the area. We thus have subprovinces within provinces and the geologically related conditions may be either vertical or lateral, or they may be stratigraphic or structural.

A possible province is a "maybe" province. The word **possible** is a very useful term for geologists and is especially apt when referring to the future.

A "future" province is one that is not as yet discovered, or at least whose development is just beginning. It might be likened to an airplane that is now on the drafting boards of the aircraft company. The plane may actually never be built and flown as it is now visualized—but once the aircraft company gives up hope of ever making a new kind of airplane, much of the company's incentive to exist is lost. The oil industry, likewise must keep visualizing its future supply of petroleum. When it fails to visualize future and undiscovered provinces, then it must think in terms of other sources of supply—and these may carry great risk both to itself and to our national safety. Whenever we give up hope of discovery, then much of our incentive to drill is lost. And when we stop drilling, then we stop discovering.

The Factors Involved

Before discussing some of the possible future provinces, I believe it would be worth while to mention a few of the factors that are involved in our thinking on the problem.

- A province, as an oil or gas pool, is found only by drilling a well. A drilling well is one common denominator of all oil and gas-pool discoveries—the only other is that all pools are found in traps. The geologist and geophysicist merely select the best location for the well to test the trap—it is the drill that really decides whether the oil is there. This point leads us to a related factor.
- A favorable economic and political climate is necessary if wells are to be drilled to discover the oil that is under the ground. If, for example, I

were a barrel of oil, comfortably located in a pool, hidden in a trap deep in the ground, the region that would be the safest for me—where I might live out another 50 or 100 million years in peace and dignity—would be in some country where minerals and exploration are nationalized, such as Russia, Mexico, or Brazil. The reason is that in countries such as these, there is but one hunter, and the chances of eluding him are far better than are the chances of being discovered. The most dangerous place for me to live, as a barrel of oil, would be right down here along the Gulf Coast, where there are a thousand hunters and each has a different weapon. When we talk of future undiscovered oil and gas provinces, then, it is with the understanding that there will be enough incentive to drill the wells necessary to find them—for without the drill, all the favorable geology in the world will not get us a new province.

This discussion will apply only to the United States and Canada where we are most interested and where the incentive to discover still exists for us.

● Provinces do not come with a calling card and pound on our door to get in. They more often slip in unannounced or with very little advance notice. In fact, the lack of enthusiasm that attends so many of the important pool discoveries that open up new provinces is one of the puzzling elements of petroleum exploration. Elk City field in the Anadarko basin, for example, was almost passed up—only when the electric log was reexamined was the decision made to set pipe.

Almost the same story occurred with the discovery of Tioga field in North Dakota that opened up the Williston basin province. The well went through nearly a thousand feet of Mississippian limestone pay formation without realizing it, and when the deep pay was tested, the drill-stem test was so poor that the recommendation to pass it up was sent to the head office. Only when it was noted in the report of the production department that the grass on the lee side of the well showed an oily luster did the men in the head office order the pipe to be set and the well tested.

Still another example of the discovery of a pool that opened up a new province occurred in 1947. At a meeting of the "high brass" in a company's office in Toronto, the decision to abandon the well drilling near Edmonton was agreed on. The chief geologist was instructed to call the Calgary office and shut the well down—the drill was in the D-2 of the Devonian and showed nothing. As he had a golf game on that afternoon—and besides it was the noon hour in Calgary—he postponed phoning the message until the next morning. That was the night the first oil showed in the D-3 zone of Leduc well—and one of the great provinces of the world was opened up. So many dry structures had been drilled in the region that enthusiasm was low, and if this one had been dry too, the ultimate discovery would have been delayed still longer. Many more such examples could be cited—but these three point up the fact that important discoveries often ride on a slender thread—and the fact that no one likes an area now is no reason that it will not ultimately produce oil.

● The normal, orthodox, sequence of exploration of a new region is as follows:

Phase 1. All structural traps are drilled first. These may be located by surface mapping, by subsurface mapping, or by geophysical surveys. The big advantage of drilling the crest of an anticline is that all reservoir rocks between the surface and the basement are deformed into traps, and one well will test many traps.

Phase 2. After the structures have been tested, the stratigraphic data found in these wells are combined with the structural information, and the combination traps, consisting of part structure and part stratigraphic, are drilled. This is more difficult exploration, as generally the objective is only one reservoir rock in each well.

Phase 3. Finally, after all the structural and combination traps have been tested, the purely stratigraphic traps are drilled. In those provinces where patchy sands, shoestring sands, deltaic sands, reefs, etc., produce oil with little or no local structure, the slightest evidence is worth drilling. In fact, exploration there often resolves itself into shutting one's eyes and drilling anywhere.

Many of the Rocky Mountain provinces are still in Phase 1, West Texas is in Phase 2, and the Bend Arch and the East Central Oklahoma areas are largely in Phase 3. The different phases often overlap, or some may even be eliminated, as for example, Phase 1 was quickly exhausted in the Cretaceous province of southwestern Nebraska, and development immediately went into Stages 2 and 3. The point to remember

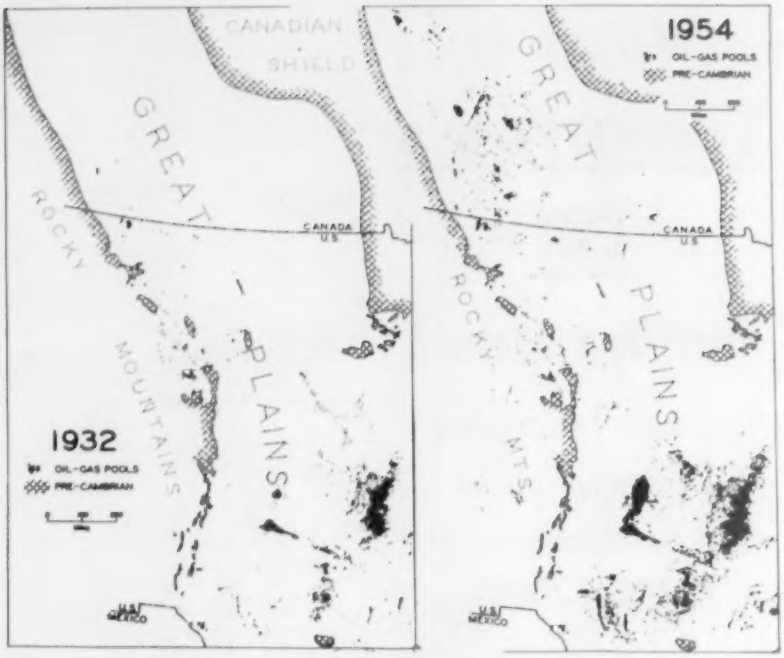

Fig. 2—A continued blackening of the map might well be expected throughout the Great Plains region in the next 20 years. Here is what happened in the past 20.

THE AUTHOR

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Fig. 3—The thrust-belt areas of California, the Rocky Mountains, the Ouachita-Marathon region, and the Appalachians all comprise possible future oil provinces.

in thinking of the exploration sequences is that new subprovinces are discovered in each of these phases.

● The importance of unconformities cannot be overemphasized in thinking of both past and future oil and gas provinces. An unconformity is the boundary surface between two layers or sequences of rocks; nearly every province has several unconformities and some have a dozen or more. The effect of an unconformity is to mask the underlying rocks—a familiar modern example is the surface separating the snow and ice of the Greenland glacier from the underlying rocks. Until one has drilled through the glacier, but little is known of what is below it. The continuing discoveries and long life of many of our provinces are often due to the fact that deeper unconformity surfaces are penetrated by the drill and new rocks and new geological conditions are discovered—most of which were unsuspected. Unconformities help explain, for example, why some of the richest pools of the Permian basin were found 30 years after the province was discovered.

● A number of years ago, I went to work as a geologist of E. H. Moore, one of the great wildcatters of Oklahoma. He called me in one day and made a remark that I believe bears repeating now. It was this: "How far do you think I should be **restrained** in my operation by scientific opinion?"

Practically all of our fear about the lack of future provinces comes so frequently now, as it has for as long as I can remember, from those who know the most about what has happened in the past—the more knowledge they have, the less future they see. They are, in effect, knowledge-bound. Scientists can only predict from what evidence they can see and measure, and current discoveries have always exhausted all of the possible orthodox scientific predictions. Much of what we predict, when we think of future discoveries, must be based on unknowns or on the most sketchy information. To get more from the scientists, then, we must have more unorthodox information available if they are to continue to make predictions. Probably no geologist was so unorthodox as to predict East Texas, West Texas, Alberta, or many other provinces. We must admit that scientific geological opinion does at times restrain operations—it is necessary that the geologists continually get new evidence to work with so that they can function most effectively.

A dim light . . . When we stop to think about future petroleum provinces, we are really stepping out into an unknown area where the light is very dim. The evidence that can be used is at best fragmentary, and an opinion that some barren region will eventually produce oil and gas is generally made when every trap located by orthodox means has been drilled, and every known theory has been tested. Such an opinion is bound to be unorthodox and can only be made if it is based on some hitherto unkonwn or unused evidence—in geology this could be an unconformity, a reefing condition, a facies change, or buried folding and faulting. Our experience shows that these things occur frequently — in fact, practically every province contains many such factors that are completely unpredictable.

Is it not reasonable, then, to expect that every large unexplored or partially explored sedimentary region contains unknown factors that may be favorable to oil and gas accumulation? In the last analysis, therefore, we can say that almost every sedimentary section contains a potential oil province until it has been systematically drilled to the basement rocks throughout its extent.

Possible Future Provinces

We now come to suggesting some specific areas that may prove to be petroleum provinces in the future. We are not so concerned with small subprovinces as we are with the larger provinces—for it is only by the discovery of many large oil and gas pools that we can hope to supply our needs of the future. I am omitting the offshore provinces from this discussion.

The Great Plains region of the United States and Canada . . . The Great Plains region extends from northwestern Canada south to Rio Grande—an area some 2,500 miles long and from 200 to 600 miles wide. At the south end of the region we have the Permian basin province of western Texas and New Mexico, shown in Fig. 1. The oil fields of the Permian basin are shown as they existed in 1925, 1934, 1944, and 1954, or at 10-year intervals. You will note the progressive blackening of the map as discoveries were made and new pools developed. As new unconformities were crossed, new geological conditions were discovered, and new waves of discovery followed. Rocks of all ages from Permian to Cambrian were found productive—and richly productive—in this province. And I can assure you that no one at any time could know where the next discovery was to be made. The area is in fact an excellent example of the meaning of the word "possible"—for while no one knew where the next pool was located, hope never died. Many knew that more pools were possible, and the search continued.

If we now think of the Great Basin

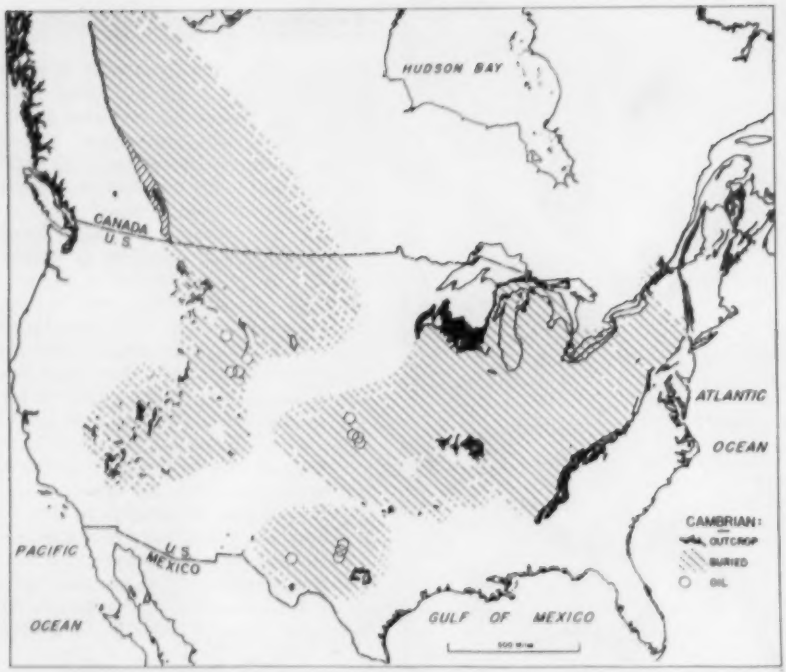


Fig. 4—The Cambrian is believed to offer great oil possibilities for the future. Map shows the distribution of the Cambrian in the United States and Canada.

region in terms of what happened in the Permian basin province, we see the record of the past 22 years in Fig. 2. One map shows the oil and gas pools as they were in 1932 and the other the pools as they were in 1954—and the blackening of the map during that time, due to new discoveries, is readily observed.

Are we heading, in this immense Great Plains region, for a repetition of what has happened in West Texas? May we not think of the Permian basin province as a hand-specimen of the Great Plains? The rocks are the same, the geologic history is comparable, and the kind of oil and gas pools are of a similar pattern. There certainly is no strain on our imagination to see a continued blackening of the map during the next 20 to 30 years throughout this Plains region. This is a region already of many provinces but many more subprovinces may be expected. It is well to remember that the two largest oil pools in the Western Hemisphere—East Texas and Pembina—occur in Upper Cretaceous rocks and are located over 1,800 miles apart, and much of the intervening region is underlain by equivalent Cretaceous rocks that are already productive in many places. Who can say that we have found the last Pembina or East Texas pool? Or the last Cretaceous subprovince?

The many basins and belts . . . Most geologists have their own ideas as to where the potential provinces are located. A summary of some of the more commonly mentioned possible future petroleum provinces in the United States and Canada is shown on the map in Fig. 3. They include:

- The 30,000-40,000 ft. of Paleozoic sediments of the Arizona-New Mexico-Utah-Nevada region.
- The thrust-belt areas in California; the Rocky Mountains of Canada and the United States; the Ouachita-Marathon region of Oklahoma and Texas, and the Appalachian region.
- The Raton basin and Trinidad basin, New Mexico, and Colorado.
- The Sierre Grande arch of New Mexico and Colorado.
- The Palo Duro basin, northwest Texas and New Mexico.
- The Anadarko basin, Oklahoma.
- The Forest City basin, Missouri, Kansas, and Nebraska.
- The Salina basin, Kansas and Nebraska.
- Eastern Nebraska.
- Eastern Dakota and Manitoba.
- Cretaceous formations of the Great Plains and Rocky Mountains.
- The Lower Cretaceous and Jurassic rocks wedging out across the southern end of Appalachian Mountains and into Florida.

Cambrian rocks . . . The present distribution of the Cambrian rocks, both where they crop out and where they are buried, is shown in Fig. 4. The places where oil and gas have been found in Cambrian sediments in Wyoming, Kansas, and Texas are shown by circles.

Sediments of Cambrian age have not been considered seriously as reservoir rocks in the past and have seldom been drilled. The reason is that in those places where they have been found to produce oil, there are nearby, younger, rocks that are widely productive, and these are generally thought to have supplied the oil found in the Cambrian. Geologists are not sure that oil was formed in Cambrian rocks, and consequently the Cambrian oil is merely thought to be due to the fact there is a permeable connection that permits leakage from some nearby source. In fact, Cambrian production is generally considered in this respect to be similar to production in pre-Cambrian and basement granites.

There are so many pools now producing oil from Cambrian rocks, however, that the time has come, it seems to me, to examine the Cambrian system more closely as a potential, widespread, reservoir rock. As may be seen in Fig. 4, Cambrian rocks underlie large areas in the United States and Canada. They are chiefly sandstones, dolomites, and shales, and the sands are often extremely permeable. Thicknesses vary greatly and range up to many thousands of feet, wedge-outs of permeability undoubtedly occur. Except for the lack of provable, indigenous oil and gas, Cambrian sediments seem to represent almost ideal potential reservoir rocks; and it should also be noted that no geologist has yet proved that oil was not formed during Cambrian time and in Cambrian rocks.

All folding that folds the younger

"It is well to remember that the two largest oil pools in the Western Hemisphere—East Texas and Pembina—occur in Upper Cretaceous rocks and are located over 1,800 miles apart, and much of the intervening region is underlain by equivalent Cretaceous rocks that are already productive in many places."

rocks also folds the Cambrian, and in addition there are folds and faults in the Cambrian that do not reach into the younger sediments. There are, consequently, many traps in Cambrian rocks, both structural and stratigraphic, that have not been tested.

If oil can be proved to be indigenous to the Cambrian, then there is no question as to Cambrian rocks eventually being found widely productive. But, even if oil is not formed in Cambrian rocks, there is enough unknown early Paleozoic folding, faulting and overlapping, that leakage into the Cambrian at some point or at many points, may supply a source of oil. And it could be large. In fact, the large scale of Cambrian deposits, their permeability and the many large untested traps, offers the extremely inviting possibility that the Cambrian will become the next great producing system in the United States and Canada.

Certainly, if I were in charge of one of the great company organizations exploring all over the world, I would drop down to the lower floor some day and dig out a geologist or two from under the pile of papers where they are now buried, and turn them loose on a regional analysis of the Cambrian possibilities. The payoff could be large!

Idea provinces . . . There is still another kind of province—it might be called an "idea" province. It consists of associated oil pools that are related to some one principle or idea. Anticlinal pools are one example, as are also stratigraphic traps. Pools that depend on fracturing, or upon some special electric log interpretation, are others. Each idea may apply particularly well to a certain region and upon certain geologic conditions, and thereby becomes the guiding principle in the exploration of the area.

Let me point out three of the many ideas that are being looked into and that may ultimately develop substantial new oil and gas production.

● **Unorthodox Reservoir Rocks.** Geologists do not like to operate much beyond their evidence, and when the evidence is negative, they find it relatively easy to follow it and become negative in their thinking. We might say that many of us who are geologists have been undergoing a form of low-grade metamorphism over the years—a geological term that means that under relatively low pressure and temperature, the mineral grains become oriented in the same direction; they fit close together; and the chemicals from many original minerals are recomposed to form a uniform new mineral extending throughout the rock. The rock now offers the greatest resistance to change. A calcite crystal in such a rock stands out like a sore thumb—it is the unmetamorphosed mineral in a metamorphosed mass. But it is in following the calcite crystal that we frequently find the ore—and maybe what we need is more calcite crystals among us geologists. We need, in fact, the unorthodox explorer.

Three kinds of rocks have in the past, for example, yielded pools where conditions were favorable — that is, where the rocks were permeable and where there was a trap, yet are generally given a low rating as potential reservoir rocks by geologists. These include: (1) The pre-Cambrian and the basement rocks generally, igneous and metamorphic rocks such as granites, gneisses, slates, etc.; (2) the volcanic rocks such as tuffs, agglomerates, and other volcanic debris; and (3) rocks of continental or fresh-water origin. All are present in large volumes in the United States and Canada, each contains oil occasionally, and each has been tested at only a relatively few places. In mentioning possible future petroleum provinces, then, areas with rocks in these catagories should not be omitted.

● **Fluid Phenomena.** Heretofore geological and geophysical work has been concerned chiefly with the rocks themselves—their history, structure, density, extent, magnetics, reflecting power, etc. But we do not produce or sell the rocks or the contours, we produce and sell the fluids—oil and gas! We need to get closer to our product.

There is currently much research and investigation by the geologists on the flow of fluids in the rocks. This is a field that in the past has been the concern of the petroleum engineers, but the geologists are finding much that is helpful to them in their search for new oil and gas pools.

One application of fluid-flow phenomena is in the displaced oil pool and in the pool with a tilted oil-water contact. This concept has been explained by Hubbert, and its application promises to aid in the discovery of many overlooked oil pools, especially in regions of considerable topographic relief, as in the Rocky Mountains and California, as well as in many of the foreign regions. Fluid-flow phenomena also aid in the search for stratigraphic traps, faults, and concealed reservoir rocks with variable permeabilities. Prospects can, in fact, be found at relatively low costs, by hydrodynamic analysis.

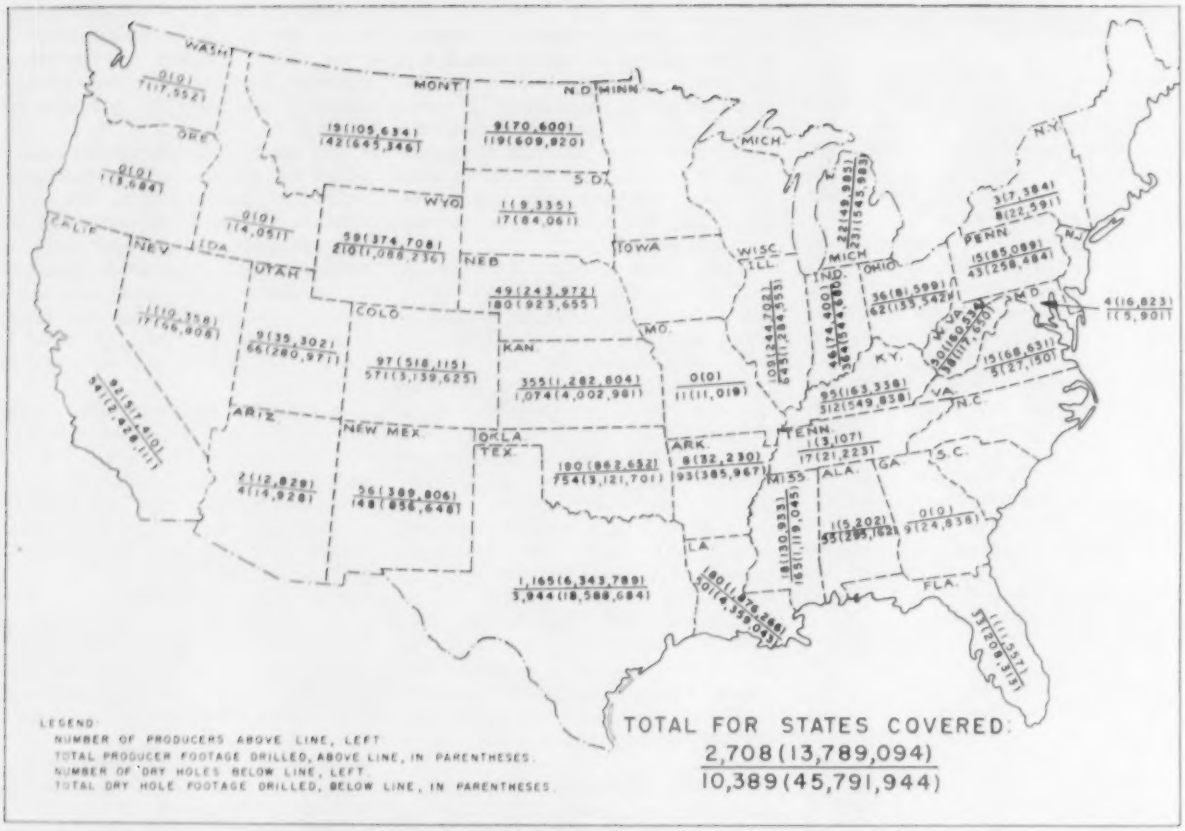
The most important information required for the practical application of fluid-flow phenomena is the fluid pressure in the reservoir and in the reservoir rock. It becomes probable, therefore, that exploration geologists will demand much more and better reservoir pressure data in the future than they have in the past. And in return, they should do a better job of oil-finding.

● **Complete Recovery.** One of the greatest potential targets for the wildcatter in ideas in America is the development of some method of recovering the presently nonrecoverable oil left behind in the primary and secondary-recovery processes. In amount, it probably exceeds all of our past production. The efforts of late have been largely in the direction of heating or burning the oil in place in the ground, thereby freeing the oil from the sand and driving it toward the producing wells. Most company research organizations have some work going forward in this field, and it promises to continue until a practical and economic method is discovered. Complete recovery, indeed, is more than a pious hope.

It Has Never Been so EASY

In conclusion, I would say that there still appears to be about as many possible future oil and gas provinces in sight as there ever were in the past. At no time that I can remember have we been able to visualize more than a fraction of the provinces that later were discovered. When we remember that most of our provinces were discovered in spite of orthodox, conventional, exploration opinion—as evidenced by the low lease prices or by the general lack of leasing in many of them—then the picture today is no worse, nor is it any better, than it was 10, 20, or 30 years ago. "It has never been so tough to find oil"—is a common expression that has been repeated through the years—and we might also say, "it has never been so easy." I, for one, see no lack of future supply in North America if we maintain the incentive to explore.

"One of the greatest potential targets for the wildcatter in ideas in America is the development of some method of recovering the presently nonrecoverable oil left behind in the primary and secondary-recovery processes. In amount, it probably exceeds all past production."



National scoreboard of 1954 exploratory drilling shows . . . FIG. 1

Fewer Wildcats, but Improved Success Rate

- Wildcat footage 59½ million feet, average 4,549
- Success rate—20.68 per cent of holes, 23.14 of footage
- One producer foot for every 3.32 ft. of hole
- Ten-year success ratio has been almost constant

by Frederic H. Lahee

This abridgement of the report of the chairman of the American Association of Petroleum Geologists' Committee on Exploratory Statistics, presented at the association's annual meeting in New York, March 28-31, is published by spcal permission of the author and the A.A.P.G. The full report will be published in the June bulletin of the A.A.P.G.

ONLY 1 new-field wildcat* out of every 44 drilled discovers a field with as much as 1 million barrels of total ultimate reserves. Nearly 98 per cent (97.74) of all new-field wildcats drilled are failures in that they are abandoned as dry or they discover reserves too small, on the average, to be profitable.

New-field wildcats have comprised 54.33 per cent of the total number of exploratory holes in the last 10 years. Of these new-field wildcats the percentage located on technical advice has risen from 85 per cent to nearly 93 per cent during the last 10 years. In this same period more than three times (3.16) as many new-field wildcats have been successful when located on technical advice as those not so located. Taking all new-field wildcats into consideration, there has been an almost constant success - to - failure ratio. The average for the 10 years has been 11.34 per cent, with a range from a low of 10.65 per cent to a high of 12.22 per cent. That is, one hole in every nine has found some oil or gas.

*New-field wildcat: An exploratory well drilled on a structure not yet producing.

1954 exploratory drilling . . . During

TABLE 1—CLASSIFICATION OF EXPLORATORY WELLS.

		I. Classification When Drilling Is Started	II. Classification after Completion or Abandonment	
			Successful	Unsuccessful
		A	B	C
Drilling for long extension of partly developed pool		1 Outpost (Extension test)	1 Extension well (Sometimes a new-pool discovery well)	1 Dry outpost (Dry extension test)
Drilling for a *new pool* on a structure or in a geological environment already productive	New-pool tests: Drilling within limits of proved area of pool — For new pool above deepest pool	2a Shallower-pool test	2a Shallower-pool discovery well (Sometimes shallower-pool extension well)	2a Dry shallower-pool test
	New-pool tests: Drilling within limits of proved area of pool — For new pool below deepest pool	2b Deeper-pool test	2b Deeper-pool discovery well (Sometimes deeper-pool extension)	2b Dry deeper-pool test
	New-pool tests: Drilling outside limits of proved area of pool	2c New-pool wildcat	2c New-pool discovery wildcat (Sometimes an extension well)	2c Dry new-pool wildcat
			New-pool discovery wells (Or, in places, extension wells)	Dry new-pool tests
Drilling for a *new field* (on a structure or in an environment never before productive)		3 New-field wildcat	3 New-field discovery wildcat	3 Dry new-field wildcat

1954, 13,097 exploratory holes were drilled in the United States. Of these 7,380 were new-field wildcats, 3,085 were new-pool tests (including new-pool wildcats, deeper-pool tests, and shallower-pool tests), and 2,632 were outposts. Among the new-field wildcats, 902 were successful; among the new-pool tests, 883 were successful; among the outposts, 923 were successful.

The exploratory footage drilled in the United States in 1954 was 59,581,038 ft. in the 13,097 holes, or 4,549 ft. per hole. These figures compare with 60,702,371 ft. drilled in 13,313 exploratory holes, with an average depth of 4,560 ft., in 1953.

In the states covered in this review, as shown in Fig. 1 and listed in Table 2, during 1954, a total of 59,581,038 ft. was drilled in 13,097 exploratory holes, divided as follows:

	Feet
2,708 producers	13,789,094
10,389 dry holes	45,791,944

This means that 20.68 per cent of the holes drilled, and 23.14 per cent of the footage drilled, were successful in 1954. One producer foot was drilled for every 3.32 ft. of hole. One successful well was drilled for every 3.83 dry holes. The average depth of hole was 4,549 ft.

Attention is called to the average depth figures for the various producing classes and for dry holes, and totals, at the bottom of the footage columns in Table 2.

Reasons for drilling . . . In Table 3 are

TABLE 2—NUMBER OF OIL WELLS, GAS WELLS, CONDENSATE WELLS, AND DRY HOLES DRILLED IN UNITED STATES AS EXPLORATORY TESTS IN 1954

	Oil producers		Gas producers		Condensate producers		Total producers		Dry holes		Grand total		
State—	No. of holes	Footage	No. of holes	Footage	No. of holes	Footage	No. of holes	Footage	No. of holes	Footage	No. of holes	Footage	Average depth of holes*
Alabama	1	5,202	0	0	0	0	1	5,202	55	295,162	56	300,364	5,364
Arizona	1	6,339	1	6,490	0	0	2	12,829	4	14,928	6	27,757	
Arkansas	6	20,775	2	11,455	0	0	8	32,230	93	385,967	101	418,197	4,141
California	76	417,728	16	99,682	0	0	92	517,410	541	2,428,111	633	2,945,521	4,653
Colorado	64	338,207	30	162,663	3	17,245	97	518,115	571	3,139,625	668	3,657,740	5,476
Florida	1	11,557	0	0	0	0	1	11,557	33	208,313	34	219,870	6,467
Georgia	0	0	0	0	0	0	0	0	9	24,838	9	24,838	
Idaho	0	0	0	0	0	0	0	0	1	4,051	1	4,051	
Illinois	109	244,702	0	0	0	0	109	244,702	645	1,284,553	754	1,529,255	2,028
Indiana	43	70,163	3	4,237	0	0	46	74,400	364	544,680	410	619,080	1,510
Kansas	310	1,093,676	45	189,128	0	0	355	1,282,804	1,074	4,002,981	1,429	5,285,785	3,699
Kentucky	81	133,686	14	29,652	0	0	95	163,338	312	549,838	407	713,176	1,752
Louisiana	94	916,828	34	399,026	52	560,412	180	1,876,266	501	4,359,043	681	6,235,309	9,156
Maryland	0	0	4	16,823	0	0	4	16,823	1	5,901	5	22,724	
Michigan	21	45,566	1	4,419	0	0	22	49,985	231	545,983	253	595,968	2,356
Mississippi	15	105,145	1	4,395	2	21,393	18	130,933	165	1,119,045	183	1,249,978	6,830
Missouri	0	0	0	0	0	0	0	0	11	11,019	11	11,019	
Montana	14	88,177	5	17,457	0	0	19	105,634	142	645,346	161	750,980	4,664
Nebraska	33	175,326	16	68,646	0	0	49	243,972	180	923,655	229	1,167,627	5,099
Nevada	1	10,358	0	0	0	0	1	10,358	17	66,808	18	77,166	
New Mexico	31	236,653	21	112,380	4	40,773	56	389,806	148	856,648	204	1,246,454	6,110
New York	0	0	3	7,384	0	0	3	7,384	8	22,591	11	29,975	
North Dakota	9	70,600	0	0	0	0	9	70,600	119	609,920	128	680,520	5,317
Ohio	13	36,882	23	44,717	0	0	36	81,599	62	133,542	98	215,141	2,195
Oklahoma	152	670,726	28	122,057	10	69,869	190	862,652	754	3,121,701	944	3,984,353	4,221
Oregon	0	0	0	0	0	0	0	0	1	3,684	1	3,684	
Pennsylvania	0	0	15	85,089	0	0	15	85,089	43	258,484	58	343,573	5,924
South Dakota	1	9,335	0	0	0	0	1	9,335	17	84,061	18	93,396	
Tennessee	0	0	1	3,107	0	0	1	3,107	17	21,223	18	24,330	
Texas	854	4,374,075	190	1,004,910	121	964,804	1,165	6,343,789	3,944	18,588,684	5,109	24,932,473	4,880
Utah	6	21,131	3	14,171	0	0	9	35,302	66	280,971	75	316,273	4,217
Virginia	0	0	15	68,631	0	0	15	68,631	5	27,150	20	95,781	
Washington	0	0	0	0	0	0	0	0	7	17,552	7	17,552	
West Virginia	1	1,700	49	158,834	0	0	50	160,534	38	117,650	88	278,184	3,161
Wyoming	48	304,867	11	69,841	0	0	59	374,708	210	1,088,236	269	1,462,944	5,438
Total U. S.	1,985	9,409,404	531	2,705,194	192	1,674,496	2,708	13,789,094	10,389	45,791,944	13,097	59,581,038	4,549
Average depth per hole		4,740		5,095		8,721		5,092		4,408		4,549	

*Average per well footage given only where 25 or more wells were drilled in a state.

listed the reasons for drilling the **new-field wildcats** in 1954; Table 3 is based on information available from men familiar with such statistics, each in his own state or district. According to these figures, 756 new-field wildcats drilled on technical advice (geology or geophysics or both) were successful, and 5,268 were dry; 24 holes, located for nontechnical reasons, were producers, and 406 were dry; 122 producers and 804 dry holes were located for reasons unknown. These figures show that 12.5 per cent of the new-field wildcats drilled on technical advice were producers as contrasted to 5.6 per cent successful in the case of holes located without technical advice. Therefore, in 1954, locations for new-field wildcats based on technical recommendations were 2.2 times as successful as those drilled without such advice. Seismographic methods were largely responsible for 268 producers and 1,470 dry holes, among the new-field wildcats.

Table 4 will be of interest, for it shows the relative success, as measured by the number of producers in comparison with the number of dry holes, in each year from 1944 to 1954, inclusive.

As indicated in Table 1, a hole may

TABLE 4—RELATIVE SUCCESS OF EXPLORATORY DRILLING IN UNITED STATES FROM 1944 TO 1954, INCLUSIVE

	New-field wildcats		All exploratory holes	
Year	No. of dry holes for each producer	Percentage of wells successful	No. of dry holes for each producer	Percentage of wells successful
1944	8.05	11.05	4.08	19.67
1945	7.63	11.59	3.62	21.64
1946	8.39	10.65	4.06	19.76
1947	7.80	11.32	3.90	20.34
1948	7.57	11.66	4.50	18.25
1949	7.79	11.37	3.95	20.20
1950	7.93	11.19	4.11	19.54
1951	8.05	11.05	4.30	18.86
1952	8.05	11.06	4.32	18.78
1953	7.95	11.18	3.98	20.13
1954	7.18	12.22	3.83	20.68
1944-1954, inclusive	7.82	11.34	4.07	19.74

TABLE 5—FIELDS* DISCOVERED IN 1948 AND 1951 GROUPED ACCORDING TO THEIR TOTAL ULTIMATE RESERVES AS ESTIMATED JANUARY 1, 1955

	Number of fields discovered in year indicated by reserves groupes†								
Year	A	B	C	D	E	F	Total A — F inclusive	A + B + C fields	Percentage of A + B + C fields in total fields
1948	3	3	21	65	199	81	372	27	7.26
1951	4	1	8	85	374	64	536	13	2.43

*This table refers only to the states of Alabama, Arkansas, California, Colorado, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Montana, Nebraska, New Mexico, Oklahoma, Texas, and Wyoming. It does not include gas fields unless natural-gas liquids are produced, and then the reserves figure relates only to these liquids. A few fields were omitted because of inadequate estimates, and a few producing areas, at first thought to be new fields, have become consolidated with other fields.

†In this table, A means 50 million barrels or more, B means between 25 and 50 million barrels, C means between 10 and 25 million barrels, D means between 1 and 10 million barrels, E means less than 1 million barrels, F means abandoned.

TABLE 3—BASIS FOR LOCATING NEW-FIELD WILDCATS DRILLED IN 1954

	Geology		Geophysics		Geology and geophysics		Sundry nontechnical		Unknown		Total		
State—	Producers	Dry holes	Producers	Dry holes	Producers	Dry holes	Producers	Dry holes	Producers	Dry holes	Producers	Dry holes	Grand total
Alabama	0	28	0	7	0	11	0	0	0	9	0	55	55
Arizona	0	0	0	0	2	0	0	0	0	4	2	4	6
Arkansas	6	74	0	1	0	6	0	0	0	0	6	81	87
California	6	131	0	*12	3	63	1	53	0	13	10	*272	*282
Colorado	9	137	12	69	26	40	1	34	2	103	50	383	433
Florida	0	5	1	21	0	3	0	4	0	0	1	33	34
Georgia	0	2	0	0	0	0	0	7	0	0	0	9	9
Idaho	0	1	0	0	0	0	0	0	0	0	0	1	1
Illinois	20	189	1	26	0	0	1	43	0	0	22	258	280
Indiana	10	261	0	2	0	0	0	0	0	0	10	263	273
Kansas	13	114	7	55	5	14	0	0	5	72	30	255	285
Kentucky	12	67	0	2	0	0	0	0	3	24	15	93	108
Louisiana	14	115	23	66	12	105	0	0	2	8	51	294	345
Michigan	9	170	1	9	0	0	0	1	0	0	10	180	190
Mississippi	8	115	1	4	4	33	0	0	0	9	13	161	174
Missouri	0	0	0	0	0	0	0	0	0	8	0	8	8
Montana	2	42	2	48	1	18	1	12	0	5	6	125	131
Nebraska	3	5	12	23	0	0	9	104	0	3	24	135	159
Nevada	0	1	1	6	0	1	0	9	0	0	1	17	18
New Mexico	17	71	11	41	0	0	0	0	0	18	28	130	158
New York	2	3	0	0	0	0	0	3	0	0	2	6	8
North Dakota	1	6	2	48	0	43	0	8	0	10	3	115	118
Ohio	0	1	0	0	0	0	0	0	0	0	0	1	1
Oklahoma	20	179	8	18	19	140	0	1	0	0	47	338	385
Oregon	0	0	0	0	0	0	0	0	0	1	0	1	1
Pennsylvania	2	10	0	2	0	2	0	0	0	6	2	20	22
South Dakota	0	1	1	14	0	1	0	0	0	1	1	17	18
Tennessee	1	3	0	0	0	0	0	0	0	7	1	10	11
Texas	275	1,763	84	*249	58	375	5	96	110	483	532	*2,966	*3,498
Utah	3	37	1	3	2	11	0	5	0	7	6	63	69
Virginia	4	0	0	0	0	0	0	0	0	0	4	0	4
Washington	0	0	0	1	0	4	0	0	0	2	0	7	7
West Virginia	3	8	0	0	1	0	0	0	0	0	4	8	12
Wyoming	1	57	8	45	6	30	6	26	0	11	21	169	190
Total	441	3,596	176	772	139	900	24	406	122	804	902	6,478	7,380

*Includes two dry holes based on geochemistry.

Fig. 2—Canada drilled 1,049 wildcats as shown here.

be located as an outpost with the intention of trying to extend a pool partly developed, but instead it may discover a new pool; and, similarly, a new-pool wildcat may be located in search of a new pool because it is believed to be well outside the limits of the known pool, but instead it may result in extending this known pool farther than had been expected. A majority of outposts, if successful, are completed as extension wells and a majority of new-pool wildcats, if successful, discover new pools.

Reserve data . . . Some years ago we included in our annual report a table showing the number of fields discovered each year, from 1938 to the year preceding the year reported, these fields being grouped according to a rough estimate of their total ultimate reserves from the date of discovery. The fields were grouped according to these estimates: A, meaning a total ultimate of 50 million barrels or more; B, from 25 to 50 million barrels; C, from 10 to 25 million barrels; D, from 1 to 10 million barrels; E, less than 1 million barrels; and F, abandoned. Gas fields were not included unless they also produced oil or condensate. A few fields were omitted where satisfactory estimates were not readily obtainable.

In the present report, the approach of the last 5 years is repeated, except that we are not reporting on the discoveries of 1954. We find that too little is known to permit a worth-while estimate for fields dscovered so recently. We are recording, in Table 5, estimated total ultimate reserves only for the discoveries of 1948 and 1951. Where necessary, revisions have been made of the earlier estimates of these fields discovered in 1948 and 1951. In revising these earlier estimates for discoveries of 1948, as made 3 years ago; 1 B was raised to A; 1 C was raised to B; 9 D's and 4 E's were raised to C; 26 E's were raised to D, and 2 gas wells became oil producers rated as D's; 14 D's were lowered to E; 3 F's were revived as E's; 1 gas well became an E producer of oil. Fifty-four gas fields remained gas fields.

In revising the earlier estimates for 1951 (made in January 1952), 1 E was raised to A; 4 C's, 4 D's, and 3 E's combined to form 1 field rated as A; 2 C's and 1 E combined to form another single A field; 1 D was raised to B; 5 D's and 1 E were raised to C's; 1 gas field became an oil field rated as C; 1 C was lowered to D; 53 E's and 1 F were raised to D's; 17 D's were lowered to E's; 1 F became an E, and 2 gas wells became oil fields rated as E's. Seventy gas fields remained gas fields. It is our plan to make these estimates of the fields discovered in any given year only 3 and 6 years, respectively, after their dates of discovery, and to omit the rough preliminary estimate given just after their discovery.

Exploratory Drilling in Canada

In western Canada, in 1954, 936 exploratory holes were completed, 250 of these being producers and 686 being dry holes (Fig. 2). The producers included 151 oil wells, 97 gas wells, and 2 gas-plus-condensate wells. A total of 3,985,774 ft. was drilled, 1,124,498 in producers and 2,861,276 ft. in dry holes. This means that 26.7 per cent of the exploratory holes and 28.2 per cent of the exploratory footage were successful. There were 2.54 ft. drilled in dry holes for every foot drilled in producers. For every producer completed 2.74 dry holes were abandoned. The average depth of all the exploratory holes was 4,258 ft.

"Figures show that 12.5 per cent of the new-field wildcats drilled on technical advice were producers as contrasted to 5.6 per cent successful in the case of holes located without technical advice."

Exploration—Lahee

THE AUTHOR

F. H. Lahee, geological and research counselor for Sun Oil Co., Dallas, was graduated by Harvard University with a B.A. degree in 1907. He received his M.A. degree in 1908 and his Ph.D. in 1911. He taught at Harvard from 1906 to 1912 and at M.I.T. from 1912 to 1918. He joined Sun in November 1918, and was chief geologist from 1920 to 1940. From 1929 to 1932 he was editor of the Bulletin of the American Association of Petroleum Geologists, and from 1932 to 1933 was president of that association. In 1953 the A.A.P.G. awarded him the Sidney Powers Memorial Medal.

Among the 737 new-field wildcats completed in western Canada in 1954, 143 were successful and 594 were dry. In other words, new-field wildcatting was 19.4 per cent successful. One producer was drilled for every 4.15 dry holes.

In eastern Canada, 113 exploratory holes were drilled, with a total of 212,987 ft.; 11 of the 113 holes were successful, 10 as gas wells, and 1 as an oil well, and all in southwestern Ontario. In these producers, 15,077 ft. was drilled. Of the 113 holes, 917 per cent were successful; 7.1 per cent of the exploratory footage was in successful holes. For every foot drilled in producers, 13.12 ft. was drilled in dry holes. The average depth of hole was 1,884.8 ft.

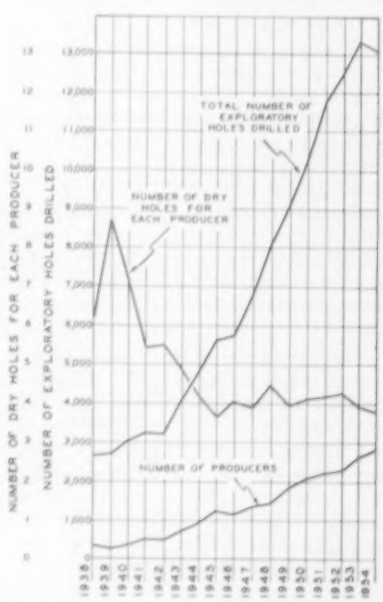


Fig. 3—Relative success of exploratory drilling in United States from 1938 through 1954.

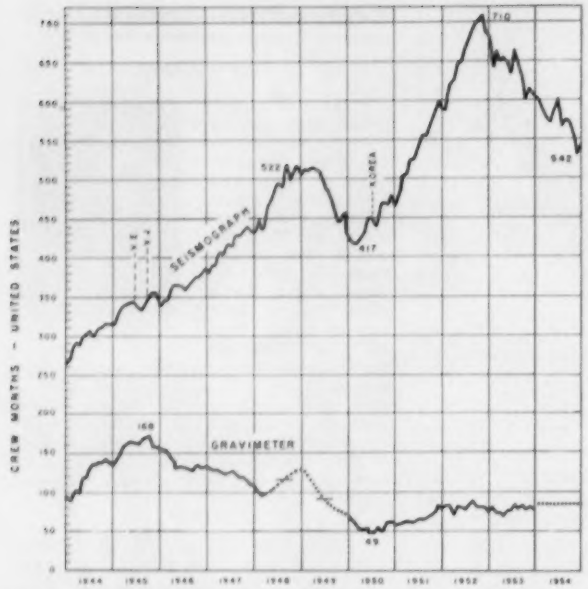


Fig. 1-A—Monthly variations in seismograph and gravimeter crew-months in the United States.

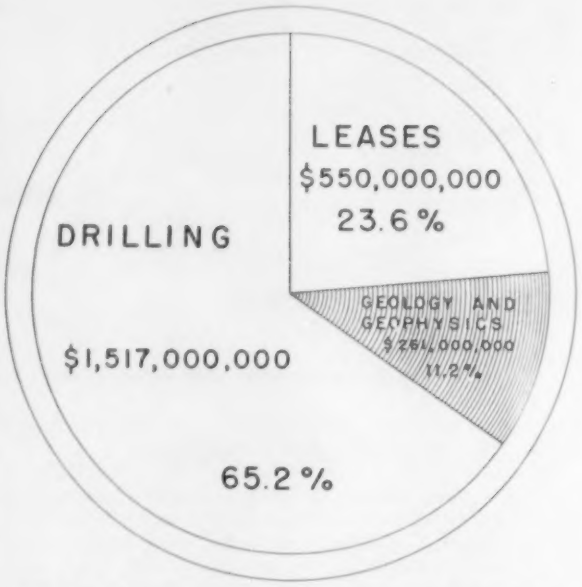


Fig. 1-B—Division of petroleum exploration costs, with geology and geophysics only 11.2 per cent.

Maybe it's due to poor salesmanship, but despite rising lease and drilling costs . . .

Geophysical Activity Drops Again in '54

Uranium search may provide needed shot in arm

by Sigmund Hammer

THE recent trend of decreasing use of geophysics in petroleum exploration is difficult to comprehend in the light of steeply rising costs of leases and drilling. (Fig. 1-A and 1-B). Both of these phases of exploration are strongly dependent upon geophysics for maximum effectiveness. Nevertheless, the combined costs of geological and geophysical activities continue to represent only a small fraction of total exploration costs. Fig. 1-B shows the breakdown of the latest available data* on exploration costs in the search for petroleum in the United States.

The proportion allocated to geology and geophysics during 1953 is higher than the corresponding figure for 1952 (11.2 per cent vs 10.3 per cent) but is still distressingly small from the point of view of the professional geophysicist as a member of the exploration team. Furthermore, it is probable that the recent spectacular rise in lease costs coupled with the decreased employment of geophysics last year will show an even smaller allocation to geology and geophysics during 1955. It would seem that the petroleum geophysicists, in spite of several recent excellent attempts, have not succeeded in selling their high-quality merchandise to top exploration management.

*H. J. Struth, World Petroleum Statistical Yearbook, 1954 Edition.

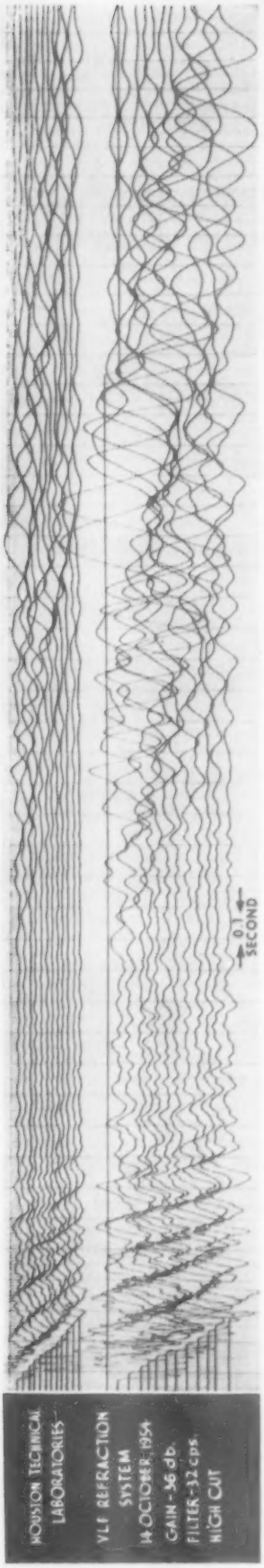
The Oil Industry

Geophysical activity in explorations for petroleum on a global scale in 1954 was 6.3 per cent lower than the record high of 1953. Notable increases in geophysical effort in Europe, the Middle East, and the Far East were not sufficient to overcome the very substantial decreases in the United States and Canada. The reduction occurred mainly in seismic operations which decreased globally by 8.4 per cent. Gravity activity was on the increase almost everywhere with a world-wide rise of 7.1 per cent. Magnetic and miscellaneous other geophysical methods also showed moderate increases in the neighborhood of 1 per cent.

The world-wide exploratory effort in 1954 utilized the average full-time services of 1,035 geophysical crews of all types. This is a reduction of 69 crews compared to the 1,105 crew total which operated in 1953.

The global distribution of geophysical activities during 1954, by area and by method, and comparisons with the statistics for 1953 are given in Table 1. Reducing the crew-months statistics in Table 1 to crew-years we find the global effort during 1954 utilized the average full-time operations of different kinds of geophysical crews as follows: seismic 862, gravity 138, magnetic 19, and others 16. The changes in numbers of crews compared to 1953 on a world-wide basis were: seismic down 78, gravity up 9, magnetic up ¼, and other methods up ¼ crew.

In the United States and Canada the average full-time number of seismic crews totaled 700, down 82 crews. Gravity crews totaled 92, up 5; and magnetic crews averaged 9, up 3. With respect to the latter, it is unfortunate that the statistics do not always differentiate between ground-magnetic and aeromagnetic crews which repre-



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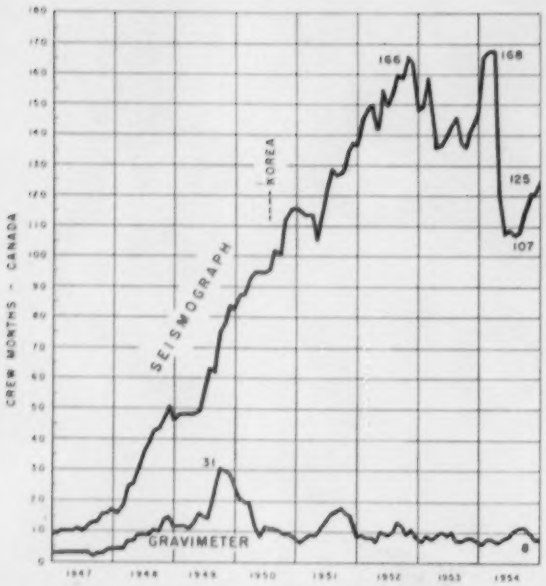

Fig. 2—Monthly variations in seismograph and gravimeter months in Canada.

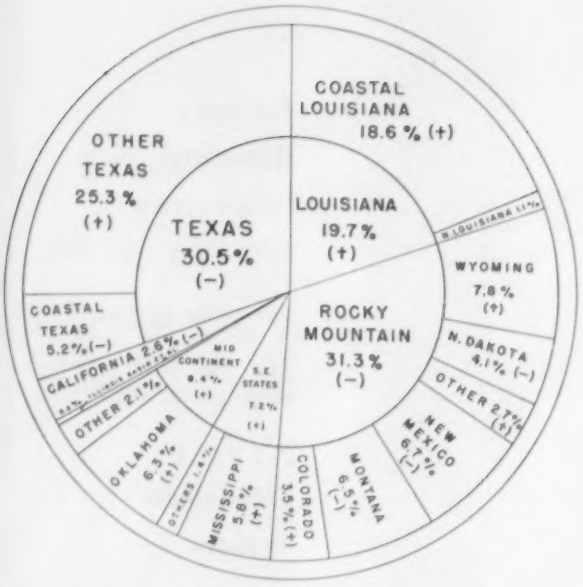

Fig. 3—Distribution of 1954 seismograph prospecting in the United States.

Exploration—Hammer

sent a tremendous difference in effort. The changes in average numbers of crews in the United States and Canada followed remarkably parallel trends with seismic work down 10.5 per cent (—67 crews) and —10.4 per cent (—15 crews), respectively, and with gravity work up 5.1 per cent (+4 crews) and 9.1 per cent (+1 crew), respectively in the two countries.

Reductions in exploration work . . . The month-by-month fluctuation of seismograph and gravity operations in the United States during the last decade is shown in Fig. 1-A. The sharp decline in seismic work which began in October 1952 continued through 1954. Seismic work in the United States declined at a fairly uniform rate throughout 1954 with an average layoff rate for the year of six seismic crews per month. The year ended with 542 seismic crews in operation in the United States. This is down to the level of seismic activity 4½ years ago in the middle of 1951. Gravity operations in the United States continued at a relatively uniform rate during 1954. Data are lacking to show complete month-by-month fluctuations, but there is some evidence of a slight gradual increase. The total number of 997 crew-months reported for the year represents an average level of employment of 83 gravity crews. The number of gravimeter crews in operation in the United States at the end of 1954 was probably in the neighborhood of 84.

Canada . . . The month-by-month variations of seismic and gravity field crews in Canada are shown in Fig. 2. The record for Canada now extends back 8 years to the beginning of 1947. The last 2 years show violent fluctuations in the utilization of seismic explorations in Canada. These fluctuations abruptly terminate a long and steady rise in the number of seismic crews which began in late 1947 and continued until October 1952 when a high of 166 crews was recorded.

Since that time the trend of seismic operations in Canada has been downwards. However, in March 1954 the number of seismic crews rose to a short-lived all-time peak of 168 crews. This was followed by a precipitous drop of 61 crews in the following 3 months to a 3-year low of 107 crews in May to August.

A recovery of 18 crews was recorded in succeeding months, and the year ended with 125 seismic crews in operation in Canada. However, the net decline of seismic work during the year represents an average layoff rate of slightly less than 2 crews per month.

The violent fluctuation in number of seismic crews in Canada during 1954 with its attendant technical personnel and equipment problems can hardly be conducive to maintaining, not to say raising, the high quality standards of the work which are so important to effectively solve the very difficult problems encountered in western Canada. Gravity work in Canada continued at a quite uniform rate, slightly higher in the latter half of the year. Eight gravity parties were in operation in Canada at the end of the year.

U. S. activities . . . The geographic distribution of seismic operations during 1954 in the United States is shown in Fig. 3. In this chart, and also in Fig. 4, changes in relative concentrations of effort in various areas compared to 1953 are indicated by (+) or (—) signs showing increase or decrease. Texas and Louisiana, as for several years past, continue in the lead. These two states

TABLE 1—CREW MONTHS OF GEOPHYSICAL EXPLORATION FOR PETROLEUM

	U.S.A.			Candada			Western Hemisphere			Eastern Hemisphere			World		
	1953	1954	% change	1953	1954	% change	1953	1954	% change	1953	1954	% change	1953	1954	% change
Seismic	7,666	6,863	—10.5	1,713	1,535	—10.4	10,173	9,209	—9.5	1,117	1,130	+1.2	11,290	10,339	—8.4
Gravity	949	997	+5.1	99	108	+9.1	1,240	1,302	+5.0	309	357	+15.5	1,549	1,659	+7.1
Magnetic	57	109	*+91.2	13	0	—100.0	153	158	+3.3	73	71	—2.7	226	229	+1.3
Other							43	162	*+276.7	151	35	*—76.8	194	197	+1.5
Total	8,672	7,969	—8.1	1,825	1,643	—10.0	11,609	10,831	—6.7	1,650	1,593	—3.5	13,259	12,424	—6.3

*Suspected incompleteness of 1953 reports suggests that these indicated large increases are questionable.

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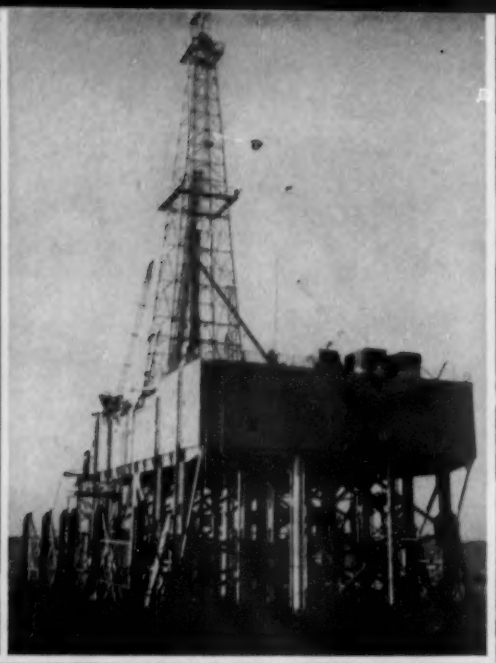

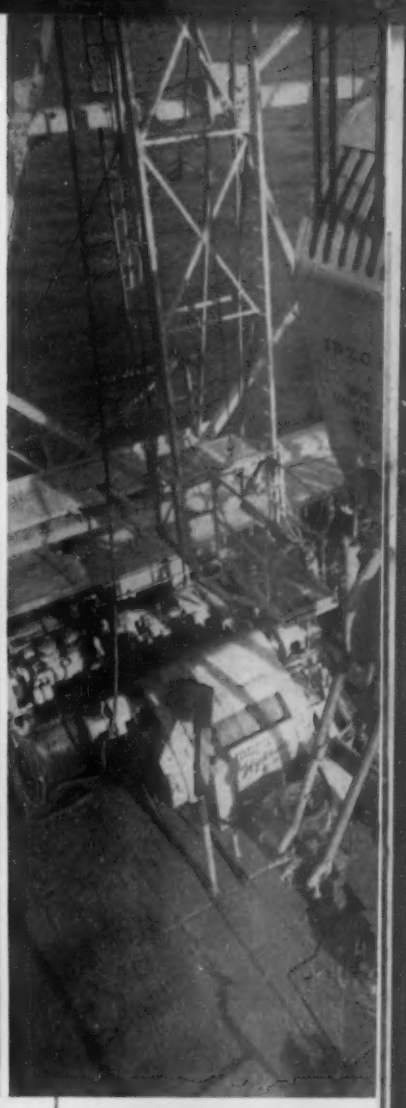

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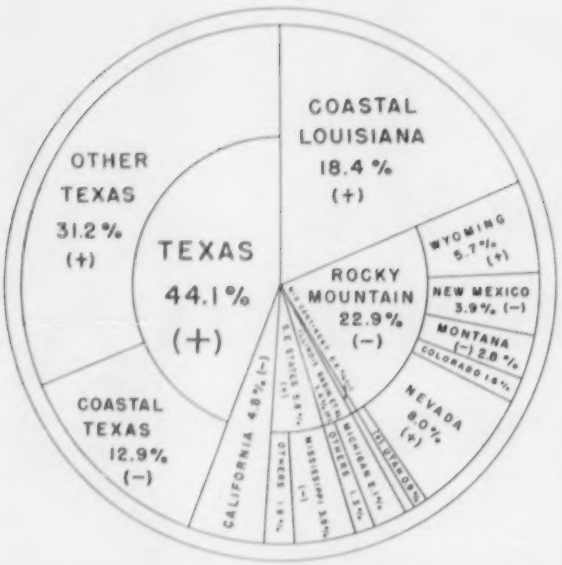

Fig. 4—Distribution of 1954 gravimeter prospecting in the United States.

together accounted for slightly more than half of all seismic activity in the United States during 1954. This is a slight increase over 1953 when the seismic total for these two states was slightly below the halfway mark for the nation.

The concentration of work in the Rocky Mountain area continued in 1954 although at a rate slightly lower than in 1953. In Wyoming the number of seismic crew-months worked during 1954 was 8 less than during the preceding year as shown in Table 2. However, due to greater reduction in the United States as a whole, Wyoming's percentage participation in 1954, as indicated in Fig. 3, was actually higher than in 1953. A major decline of seismic activity was recorded in Montana. Coastal Louisiana showed a marked increase. This reflects the influence of growing activity in the Gulf of Mexico. Substantial decreases in seismic work occurred in New Mexico and in California. A notable increase was registered in Mississippi. Other changes and shifts in seismic operations in the United States are listed in Table 2.

TABLE 2—SEISMOGRAPH CREW-MONTHS IN U. S.

State—	1953	1954	Per cent change
Texas	2,459	2,107	—14.3
Louisiana	1,268	1,303	+ 2.8
Wyoming	543	535	— 1.5
New Mexico	600	465	—22.5
Montana	737	456	—38.1
Oklahoma	404	441	+ 9.2
North Dakota	345	284	—17.7
Mississippi	191	233	+22.0
Colorado	216	228	+ 5.6
California	229	180	—21.4
Kansas	(*)	136	(*)
Others	674	495	—26.6
Total	7,666	6,863	—10.5

*State not listed separately in 1953 report.

Gravity work . . . The areal distribution of gravimeter work in the United States during 1954 is shown in Fig. 4. Considerably more than half of the total gravimeter work in the nation was concentrated in Texas and Louisiana. Last year's percentages of gravimeter operations in these two states totaled 62.5 per cent which is 3.4 per cent higher than in 1953. The Rocky Mountain area continued at a relatively high level although the 1954 total (22.9 per cent) was 30 per cent lower than in 1953. Substantial increases in gravity activity in Wyoming and Nevada failed to overcome the much larger decrease in Montana. Additional statistics on areal distribution and shifts of gravity operations in the United States are given in Table 3.

TABLE 3—GRAVITY CREW-MONTHS IN U. S.

State—	1953	1954	Per cent change
Texas	387	439	+13.4
Louisiana	174	183	+ 5.2
Nevada	(*)	80	(*)
Wyoming	30	57	+90.0
California	69	48	—30.4
Mississippi	51	39	—23.5
New Mexico	47	39	—17.0
Montana	94	28	—70.2
Michigan	(*)	21	(*)
Colorado	30	15	—50.0
Others	67	48	—28.4
Total	949	997	+ 5.1

*State not listed separately in 1953 report.

World-wide exploration . . . The world distribution of seismic explorations for petroleum is shown in Fig. 5. Although North America continues to dominate the chart, the year recorded significant increases in South America and Eastern Hemisphere. The trend towards foreign explorations reduced the North American seismic participation from 83.1 to 81.3 per cent of the total world seismic effort. Aside from this general trend there were no spectacular changes in the levels of seismic activity in the various areas of the world.

The world distribution of gravimeter operations during 1954 is shown in Fig. 6. The United States accounted for 60.1 per cent of the total world gravity effort. The United States and Canada together recorded exactly two-thirds (66.6 per cent) of world-wide gravity exploration for petroleum during the year. This is a slight decrease from the percentage total (67.7 per cent) in 1953. The apparent contradiction with the actual increase in gravity crew-months in the United States and Canada shown in Table 1, is due to the greater relative gain in other areas of the world.

It is of interest to compare the relative distribution of seismic and gravity activities. In the United States and Canada the relative percentages of seismic and gravity work are of comparable magnitudes. In other areas, notably South America and the Eastern Hemisphere, the percentages of gravity explorations are about double the percentages of seismic explorations. This indicates a very proper emphasis on gravity work, preceding seismic work, in the earlier stage of exploration in relatively unexplored areas.

A similar higher proportion of gravity to seismic activity in the United States is shown by the relatively high level of the gravimeter curve in Fig. 1 about 10 years ago. This does not imply that gravity work in the United States is approaching saturation. Rather the indication is that more gravity work is required in unexplored areas for reconnaissance to furnish prospects to increase the effectiveness of the more expensive and more detailed seismograph work to follow.

Reported magnetic activity in petroleum exploration as summarized in Table 1 shows a slight rise during 1954. The reported data, unfortunately, seldom differentiate between ground magnetometer, aeromagnetic, and other types of operations. Accepting the data at face value we infer a very substantial increase of 52 crew-months of magnetic exploration in the United States during 1954. This represents the average full-time employment for the year

Exploration—Hammer

THE AUTHOR

Dr. Sigmund Hammer, Gulf Research & Development Co., Pittsburgh, is chairman of the committee on geophysical activity of the Society of Exploration Geophysicists. The members of the committee are: Kenneth L. Cook, Herbert Hoover, Jr., C. C. Lister, Walter S. Olson, Kumiji Iida, A. Garcia Rojas, and Sigmund Hammer, chairman.

The accompanying report was presented at the society's annual meeting in New York, March 28-31.

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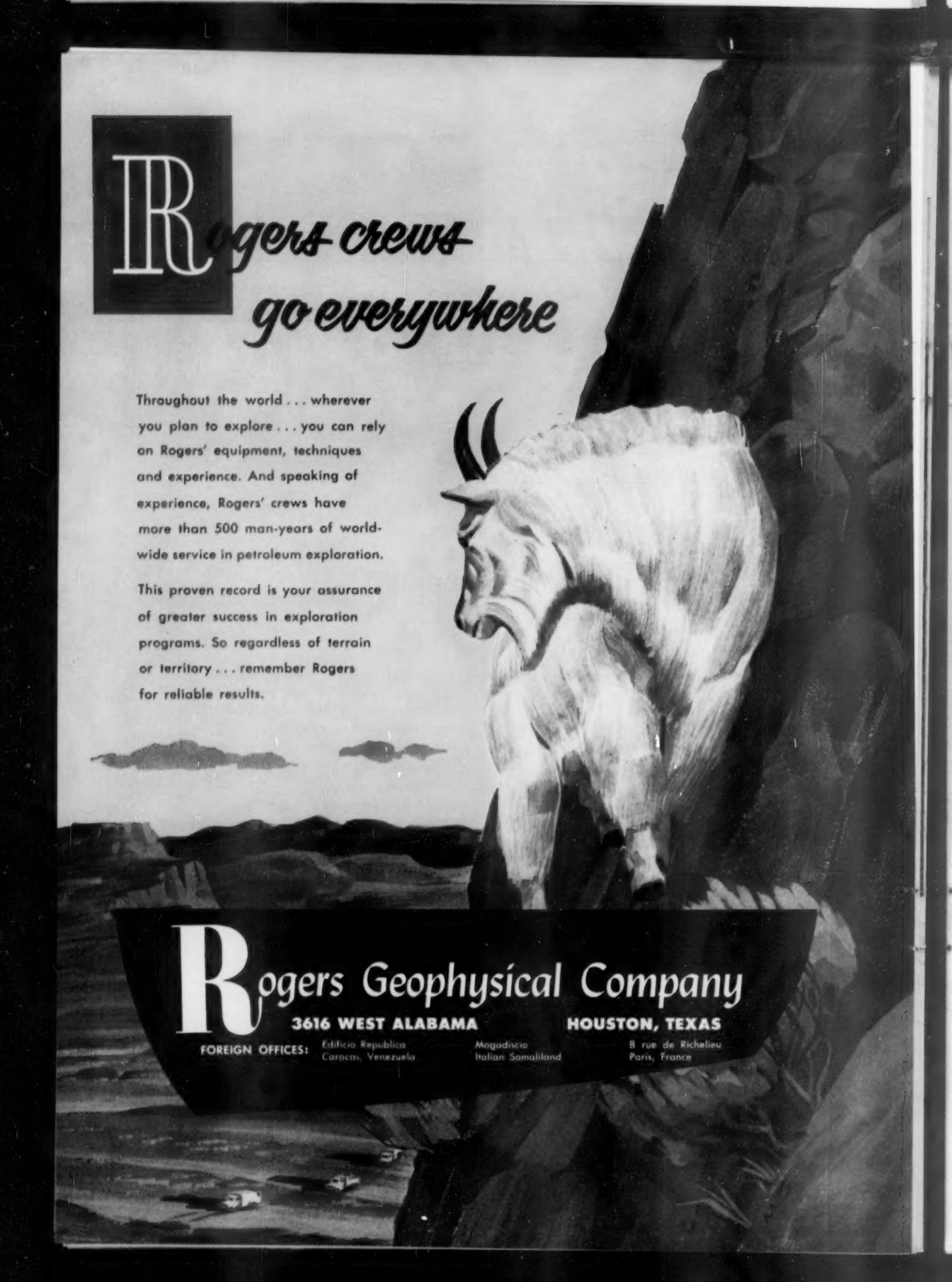
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of 9 magnetic crews. This is almost double (up 91 per cent) the amount of magnetic work reported in the United States during 1953. In the rest of the world magnetic explorations for petroleum decreased by an amount almost, but not quite, as large as the increase in the United States. Reported world-wide magnetic crew-months totaled 229 which is 1.3 per cent greater than the total for 1953. This represents a global average full-time employment of 19 magnetic crews. It may be reasonable to estimate that aeromagnetic surveying continued at about the same level as in 1953; namely, about 30 crew-months. Most of the aeromagnetic work was in the United States, but extensive surveys were reported in South America and the Far East. Canada reported no magnetic field work in petroleum exploration during 1954. However, it is known that large areas have been covered in earlier airborne surveys, and it is probable that interpretations of many of these data are still continuing. A similar remark probably applies also to vast aeromagnetic survey data elsewhere. Interpretational activities of this kind, which are a natural consequence of the high speed of aeromagnetic exploration, are not reflected in the statistics in this paper. The backlog of magnetic interpretation is therefore not known, but it is reasonable to assume that it will continue to yield important geophysical information for many years to come.

Review interpretations of records and data from earlier surveys of all types are growing in importance. The magnitude of this effort is not known. However, it represents a fertile field for growth and improvement as files and experience accumulate.*

Offshore explorations by the seismic, gravity, and magnetic methods were continued at high levels during 1954. Complete breakdown of the marine statistics is not available. However, it is known that work was done offshore Texas, Louisiana, and Florida in the Gulf of Mexico, offshore California; and in the Persian Gulf. The data in these areas, especially the Gulf of Mexico, are now furnishing indispensable guidance in the purchase and development of very high-priced leases. It is pertinent to repeat the statement made a year ago in this report that geophysics provides the only practicable methods of evaluating marine prospects ahead of lease buyer, drilling platform, and drill. The investments in offshore geophysical surveys, large as they are, shrink exceedingly when compared with the almost incomprehensible prices which are now being paid for acreage blocks on good prospects everywhere and especially in the Gulf of Mexico.

Exploration costs . . . Data on the expense of geophysical explorations for petroleum are incomplete for 1954. It is probable that unit costs were not significantly different in 1954 from what they were in 1953. On that basis, the world-wide investments in geophysical explorations during 1954 were somewhat less than in 1953. The total geophysical investment world wide was probably between $300,000,000 and $350,000,000. In the United States the geophysical investment was probably about $200,000,000.

It is interesting to consider the relation of geophysical costs to the discovery of oil reserves. Published data suggest that about 20 billion barrels of oil was found in world-wide explorations during 1954. In the United States the corresponding figure was 4 billion barrels. These estimates include revisions and extensions of reserves in previously known fields which were developed during the year. These revisions, which contribute the major portions of the added reserves, should properly be credited back to the year of discovery of the individual field. However, it is reasonable to expect that the reserves of new fields discovered during 1954 will be similarly increased in years to come, and this expectation is the only justification for using the total figures given above. If we allocate the geophysical expenditures during 1954 to the oil discovered during the year we can compute the geophysical investment per barrel of oil discovered. Such a calculation is, of course, highly oversimplified; and therefore the significance of the computed number is open to question. However, arbitrarily performing the indicated calculations yield the following interesting figures: World wide the geophysical expenditure during 1954 amounted to $0.015 per estimated barrel of oil discovered. In the United States the total geophysical expenditure during 1954 was $0.050 per estimated barrel of oil discovered.

*Norman Morrisey, "Better Seismic Interpretation Needed," The Oil and Gas Journal, February 14, 1955.

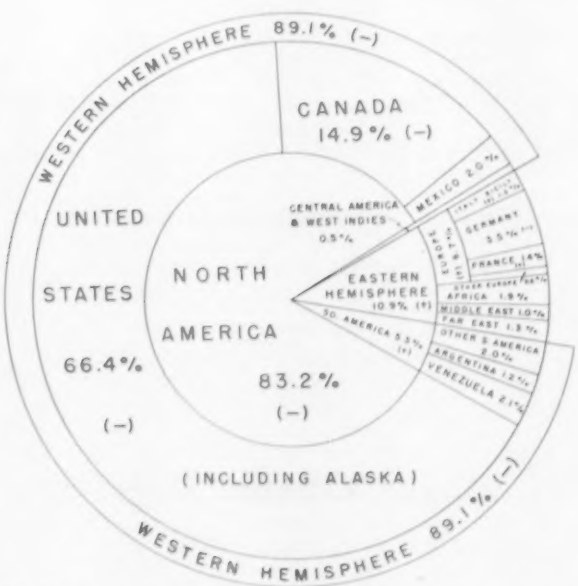

Fig. 5—World distribution of seismograph prospecting in 1954.

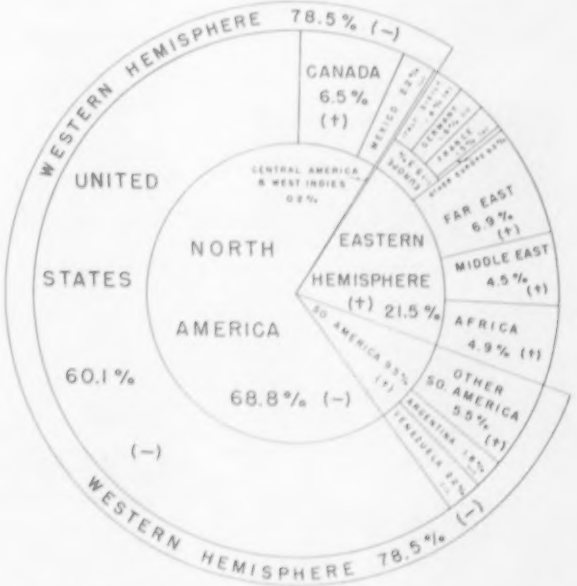

Fig. 6—World distribution of gravimeter prospecting in 1954.

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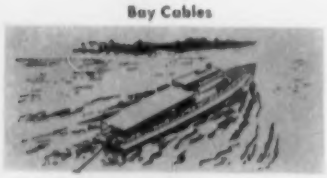

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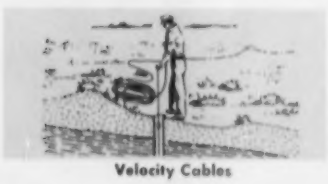

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Fig. 1—The Colorado Plateau is the scene of an active prospecting campaign for uranium. Several petroleum exploration techniques are used to map the ore bodies.

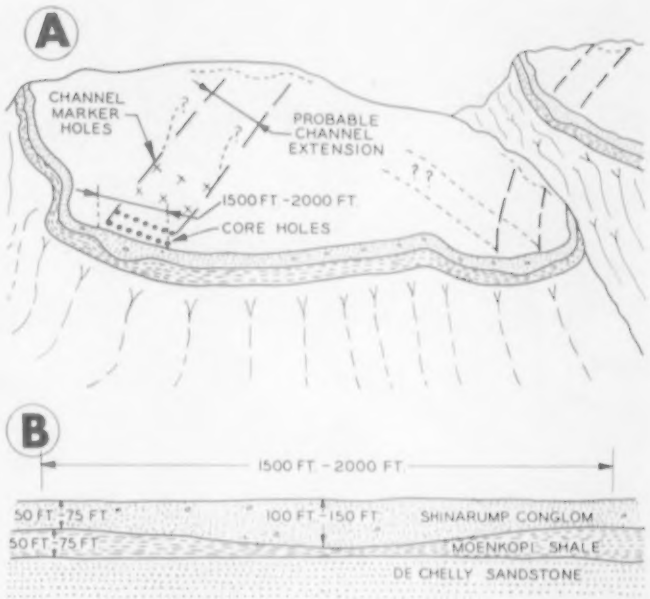

Fig. 2—The uranium-bearing minerals may occur in buried stream channels. These channels outcrop on the side of a cliff, but it is necessary to use core holes or some other method to trace the ore deposit back from the cliff face.

How Seismic Refraction Locates Uranium

. . . by tracing buried ore-bearing channels

by Dart Wantland

THE seismic refraction method can be used to good advantage in uranium exploration under favorable conditions.

This method can trace the buried channels that may contain uranium ore. These channels are visible on the sides of the mesas in the Colorado Plateau; it is an expensive and difficult task to trace such a channel back from the rim of a mesa. Core drilling or other forms of drilling are slow and costly at best. Refraction seismic work, however, was used at the Nokai Mesa, Arizona, in tracing a channel in the Shinarump conglomerate.

Uranium Prospecting and Ore Deposits

Erosion and weathering in the Colorado Plateau area have given rise to a series of flat terraces, benches, and mesas of various sizes. Some of these are only a few thousand feet in length and width, and others cover a number of square miles. On the edge of these topographic features are exposed hundreds and hundreds of miles of so-called "rim rock." Horizons that may contain uranium mineralization at different positions in the stratigraphic column can be distinguished over wide areas at and along the "ore rim." The distinctive color and character of many of the formations in the region permit the miner and the geologist usually to be certain of where he is in the geologic column. The formations change in depositional character, however, in different parts of the area.

Geology . . . Most of the important ore deposits of the plateau are found in the Shinarump conglomerate of Triassic age, and the Entrada sandstone and the Morrison formation of Jurassic age. In recent years, important uranium mineralization has been discovered in other formations and over wider areas in the plateau.[7]

Prospecting for mineral outcrops is done by following the miles of exposed rim rock. Finding an outcrop of carnotite is made easier by the fact that it has a distinctive bright canary yellow color. An ore or mineral showing is either followed and developed by underground exploration (drifts or shafts) or a portable drill is used to explore in the area back of a rim exposure.

In exploring behind an exposure, drill holes are ordinarily arranged in some geometric pattern with spacing suitable to the probable size of an ore body. Since the ore bodies are spotty and irregular, delimiting them by drilling is a difficult problem for the individual miner, as well as for the larger mining companies. The "target" is small. One drill hole may miss an ore body by a few feet—as shown by later mining—and a second hole 10 ft. away from the first one may or may not find mineralization.

Drilling out a likely mineralized area is expensive for two reasons (1) the ore bodies are small, spotty, and erratic in occurrence, as noted; and (2) the area to be explored back of an exposure increases in size geometrically as drilling progresses.

In order to improve the effectiveness of drilling for uranium ore bodies, geologists have developed criteria to evaluate drilling results.[8] The basis of this work was a study of the cores from many drill holes 25, 50, 100 ft., etc., away from known mineralization. Such criteria covered such features as color, percentage of mudstone to sandstone, apparent porosity, and other diagnostic

Fig. 3—Both truck-mounted and portable refraction seismic equipment can be used to trace the stream channels.

geological characteristics of cores. It is thus possible, within limits, to estimate the relative favorability of one part of an exploration area from another by drilling.

The origin of the uranium deposits of the plateau has not been completely worked out. Among other things, it is suggested that the carnotite was precipitated from ground waters moving through certain zones in the sandstone beds. Precipitation may have been brought about by slight changes in the composition of the waters which carried the minerals.[6]

The fact that exploration costs are increasing has brought about more interest in the possibilities of geophysical methods to aid in the search for uranium deposits.

Radiometric Geophysical Prospecting

Radiometric drill-hole logging and airborne radiometric prospecting are two special forms of geophysical investigation that have been used successfully in exploring for uranium deposits in the plateau. They are unique in comparison to the usual methods of mining geophysics that are all applied at the ground surface. A drill hole is obviously required in the logging procedures and the term airborne is self-explanatory in respect to the technique of application. These methods will be discussed briefly before examples of resistivity and seismic refraction exploration are presented.

Radiometric logging . . . Radioactivity is the most obvious characteristic of carnotite and other uranium minerals that bears on the possibilities of applying geophysical procedures toward finding it. This feature of carnotite is used in the radiometric logging of drill holes.[9] Such logging is carried on extensively by the Atomic Energy Commission; it is understood that some custom logging services by radiometric methods are available.

Radiometric logging trucks are equipped with scintillometer logging tools or with geiger-counter probes. The equipment is usually so arranged that it yields a graphic log. The radioactivity at a point in the drill hole opposite the sensitive element in the probe is recorded at the appropriate depth on the log. It is also possible to change the sensitivity of the logger.

The radiometric logging equipment employed by the commission was designed and built by them and field-tested over many months. Their scintillation loggers were first used on the plateau in the summer of 1952.

In the early development of radiometric logging certain tests under contract were carried out by The Texas Co. looking to the adaption of existing oil-well types of equipment to mineral prospecting.

The U.S. Geological Survey is also active in this form of logging. It conducts experimentation and research on equipment and the interpretation of radiometric logs.

Radiometric bore-hole logging is now standard practice with the commission in its drilling projects and these logs have become increasingly useful in establishing just where mineralization is in a drill hole. The logs show the thickness of a mineralized zone and qualitatively the amount of mineralization. It appears that it is not yet possible to assay values by such logs although experiments are under way to that end. Radiometric logs have demonstrated their value is far in excess of their cost and they are virtually indispensable in uranium exploration.

Portable geiger counters and/or scintillation counters with which the radioactivity of hand samples or outcrops can be tested are in general use.

Airborne radiometric prospecting . . . Flying the rims with powerful light

Fig. 4—At Nokai Mesa, an old stream channel in the Shinarump conglomerate was believed uranium bearing and outcropped on the cliff face.

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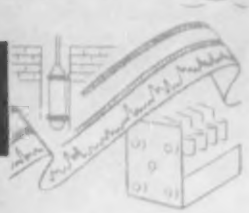

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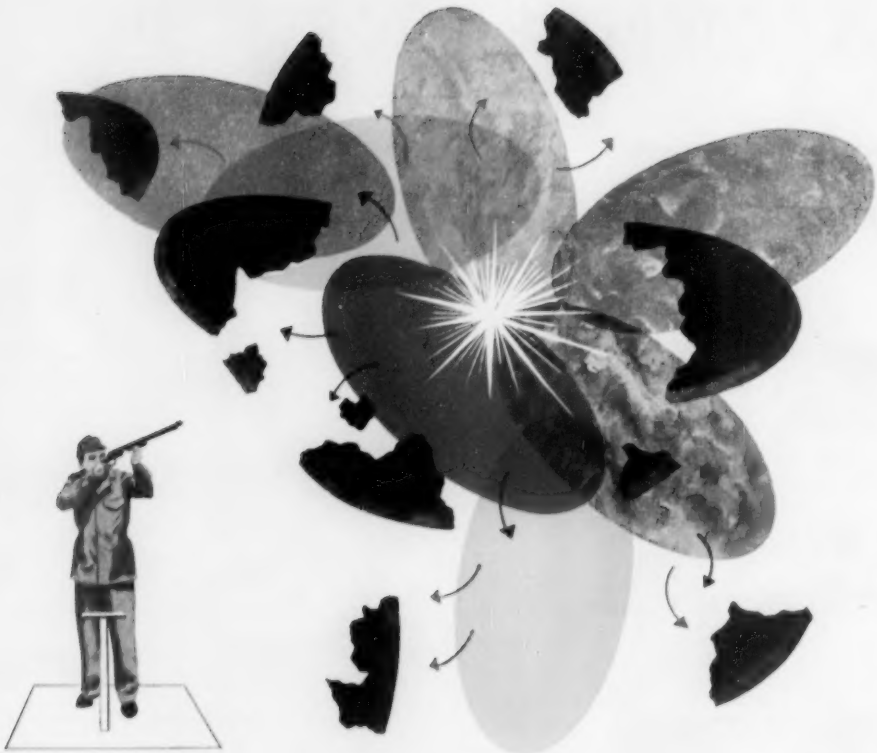

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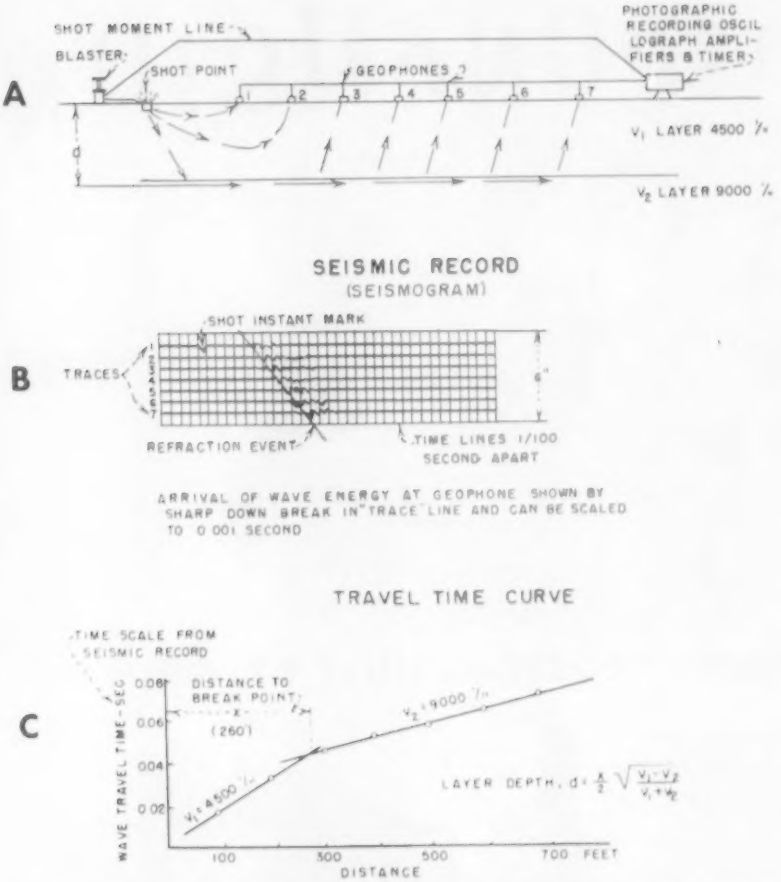

Fig. 5—The seismic refraction method can map the channels because the velocity of seismic energy in the underlying Moenkopi is greater than in the overlying Shinarump.

Exploration—Wantland

planes equipped with scintillometers is at present the best, and in fact, the only way in which sizable areas can be quickly explored and likely spots pin pointed for later detailed study.[10] The commission has certain Super Cubs fitted out for this high-speed form of uranium prospecting. Commercial airborne prospecting services are also available through several individual contractors.

The plans are flown by carefully selected pilots, preferably with crop-dusting experience. They are men who have the skill to hedge hop the rims of the numerous precipitous canyons. It has been demonstrated that flying within 200 ft. or less of the ore rim is possible.

Observers, who are also geologists, are usually carried on each flight to operate the radiometric instruments. By the use of air photos, locations are picked for later investigation by ground parties, as indicated by the findings.

The USGS is carrying on a certain amount of airborne radiometric exploration. It is of record that a number of important discoveries of uranium have been made by this rapid and modern type of exploration.

In one investigation in the plateau, radiometric airborne studies were carried out using a helicopter.[11] Although in this instance it is understood that no ore was discovered, the possibilities of such work, where the terrain is suitable, was demonstrated. Because of the great depth of the canyons and their sheer walls, in much of the plateau, down drafts and very erratic air may make the helicopter too hazardous for general use in rim flying.

Seismic Field Tests

Nokai Mesa, where the seismic investigations were made, is located in the northern part of Navajo County, Arizona. The mesa extends a few miles north into adjoining Utah (Fig. 1). Nokai Mesa is one of several such physiographic features in the Monument Valley area, on the Navajo Indian Reservation.

The region is arid and sandy and essentially uninhabited save for a few Indians and a small number of persons engaged in uranium mining. The Monument Valley area is rather inaccessible and for a distance of from 50 to 75 miles from the mesa the few roads that exist are primitive and can be traveled with certainty only in four-wheel-drive vehicles. Ordinarily about 1½ days were required to negotiate the 325 miles from Grand Junction to the Nokai field camp by car.

By the light plane, however, the trip from the AEC air strip on the mesa to Grand Junction could be made comfortably in 1½ hours. Air travel provides a thrilling view of the massive cliffs, pillars, and "monuments" into which the highly colored rocks of the area have been eroded.

Site conditions and geologic features . . . The problem under study at Nokai Mesa was to test the ability of the seismic geophysical method to map the course of a buried channel. Nokai Mesa was a suitable test site because core-drilling exploration of a channel was being carried on there by the AEC; the geologic conditions were essentially similar to those under which uranium ore bodies had been discovered in channels at other localities.

The matter of channel exploration was quite important in the search for uranium deposits in the Monument Valley area in two respects. First, it was patent that, if a geophysical method could be found whereby potentially mineralized channels could be traced in advance of or in connection with drilling, or both, exploration could be expedited. Second, a geophysical guide for drill-hole placement might well result in appreciable economies in channel exploration.

Figs. 2 A and B show typical hypo-

THE AUTHOR

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Wantland is a member of several technical societies, and the author of 36 published technical articles.

The information in this paper has been released through the courtesy of the Bureau of Reclamation and the Atomic Energy Commission.

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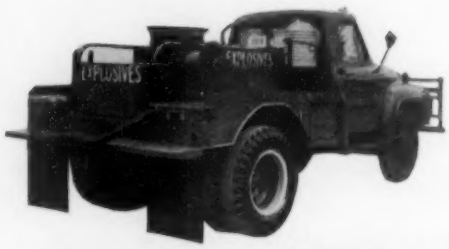

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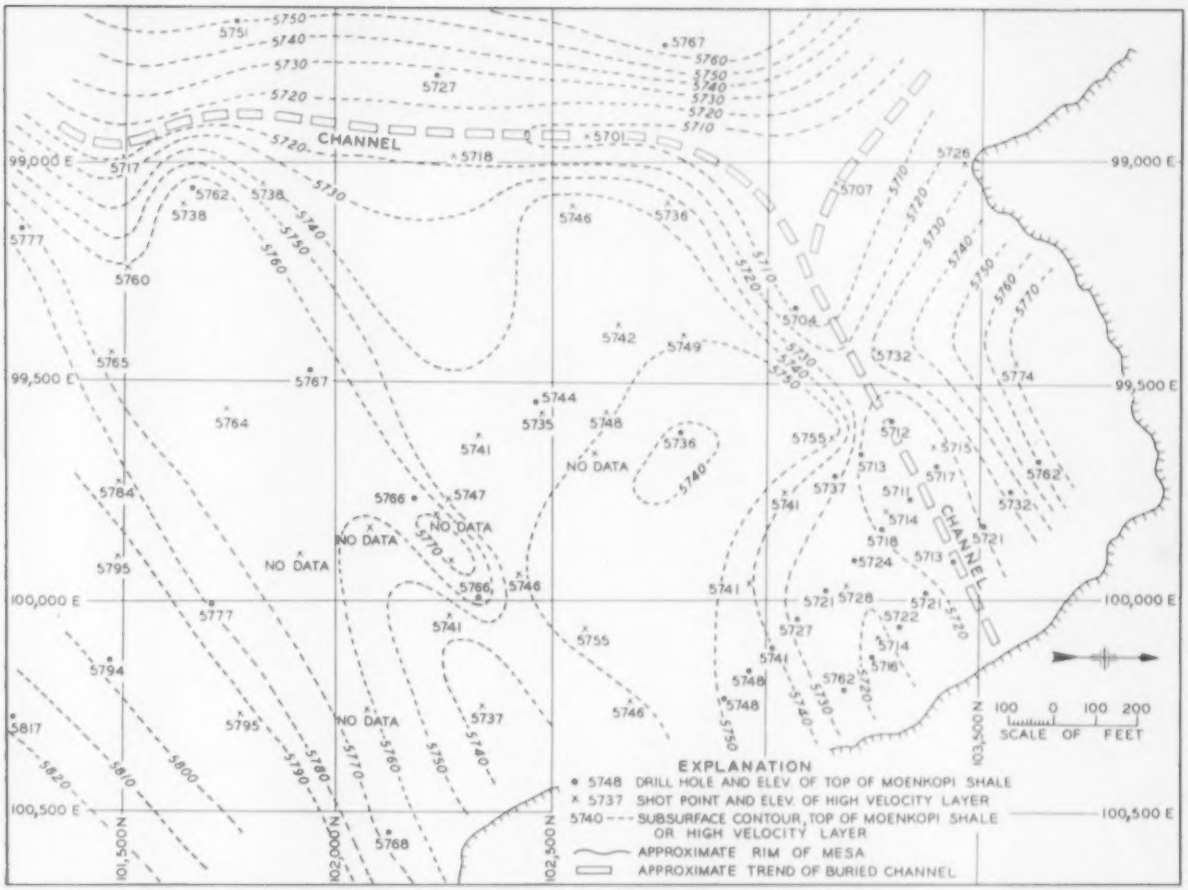
CHANNEL
99,000 E
99,500 E
100,000 E
100,500 E
NO DATA
EXPLANATION
5748 DRILL HOLE AND ELEV. OF TOP OF MOENKOPI SHALE
5737 SHOT POINT AND ELEV. OF HIGH VELOCITY LAYER
5740 SUBSURFACE CONTOUR, TOP OF MOENKOPI SHALE OR HIGH VELOCITY LAYER
APPROXIMATE RIM OF MESA
APPROXIMATE TREND OF BURIED CHANNEL
SCALE OF FEET

Fig. 6—The seismic map shows the location of the buried channel. Notice that the channel branches in the upper part of the diagram.

Exploration—Wantland

thetical buried channels on a mesa. It is evident that the position and shape of a channel can be seen only on the edge of a mesa.

The width and depth of a given channel at the mesa's edge are not, however, a definite guide as to the true configuration of the channel itself. This is because there is ordinarily little or no evidence available as to the orientation of the course of a channel from a rim exposure. For example, a broad channel as seen at the rim might simply represent a section taken on a line approaching the course of the channel in question.

Where there is a channel exposed on one side of a mesa and a channel of similar size exposed on the opposite side of the same mesa, only a questionable projection and connection of the two exposures can be made. Core drilling or drilling of other types with holes set on some form of grid at points back from the channel exposure, on the edge of a mesa, is the usual procedure for tracing channels.

The cross-section given in Fig. 2 B carries dimensions similar to those of the known channel at Nokai Mesa. In the Monument Valley area many channels are considerably smaller than the Nokai Mesa. They may be only a few hundred feet in width, with steeper side slopes than in the one pictured. Their maximum depth may be in the order of from 50 to 75 ft. with correspondingly less depth in the off-channel areas.

Local geology . . . Nokai Mesa is capped by the Shinarump conglomerate, a formation of Triassic age. Bare rock is exposed over 25 per cent of the area, but elsewhere on the mesa a few inches to 3 ft. of loose sand cover is present.

The nature of the channel is brought out in Fig. 4 at a point in the investigation area, looking northeast to the island. The channel is outlined by a dashed line on the photograph; it is clearly visible in the field. The Shinarump is light colored and contrasts sharply with the brownish-red Moenkopi shale, also of Triassic age, into which the channel is cut.

The terrain is rugged. It is featured by flat-topped mesas and sheer cliffs on the sides of canyons which are often over 1,000 ft. in depth and from one-half to several miles wide. The physical difficulties of getting from one place to another in the area, even on foot, are considerable. Establishing base camps for exploration requires much work. For example, some 15 miles of road had to be made with a bulldozer before the site picked for the field camp at Nokai Mesa could be reached by motor vehicles. Prior to this only poor pack trails led into the area.

The Refraction Seismic Method

In the seismic refraction method, a number of "geophones" (seismic wave receivers) are set out in a line, or "spread" as it is called, on the ground surface at measured distances from a shot point where a small charge of dynamite buried in a shallow hole is exploded. The explosion puts seismic wave energy into the ground which travels along the spread to the geophones where it is picked up and its arrival recorded photographically. These arrangements are shown in Fig. 5A.

A seismic record, or seismogram, is made for each shot by means of a photographic recording oscillograph

which is usually mounted in a field truck. The time required for the seismic wave or waves to travel from this shot point to each geophone can be determined from the seismic record.

The data on seismic wave time of travel and measured geophone distances from the shot point are assembled on a travel time curve, or graph, as illustrated in Fig. 5-A. From such a graph the seismic wave velocity in the different layers of material below the surface can be determined.

Fig. 5A shows the paths followed by the waves in the case where two layers of different kinds of rock are present which carry the seismic waves at different velocities. The wave paths as shown indicate that the seismic energy travels downward from the shot point to that layer which carries such energy at a higher velocity (than the overlying material), and is refracted along the top of that layer and then returns to the surface.

The depth below the surface to the top of the second layer, or layer of high seismic wave speed, is found by the formula given in Fig. 5C. This formula relates the layer velocities and the slope change or "break point" distance x of the graph and layer depth.

Where a third layer of yet higher velocity is present below the surface, three different slopes are shown on the travel-time graph. The depth to such a third layer can be found by a similar type formula, which is, however, more cumbersome because additional terms are involved.

From field measurements of seismic wave travel and the use of the data as described, it is possible to find the depth to the seismic high-velocity layer at various points in an area. The next step is to establish the relation of the seismic high-velocity layer with a geologically significant horizon. At Nokai Mesa the top of the Moenkopi shale was such a marker bed. The seismically determined depths to the seismic high-speed layer and the top of the Moenkopi formation was established at shot points which were near drill holes.

Velocity measurements . . . A velocity survey was made at three core holes to determine the speed of seismic waves, in a vertical direction, in the Shinarump and in the Moenkopi formations.

Taking into consideration the results secured from the three drill holes, the average vertical velocity was found to be 6,270 ft. per second in the Shinarump formation and 13,800 ft. per second in the Moenkopi formation.

Formation velocity conditions were suitable for the use of the refraction method; a layer of relatively high seismic wave velocity lay beneath a layer of lesser seismic wave speed. Such a drill hole velocity study is not entirely essential to the use of the refraction seismic method in mapping channels. In the investigation at Nokai Mesa, however, the velocity data were valuable as it was not known if a suitable formation velocity contrast was present between the Shinarump and the Moenkopi.

Refraction field tests . . . The refraction phase of the work consisted in making seismic depth determinations at various points in the area, presumably traversed by the channel. To this end 11 seismic spreads were completed.

An air compressor and jack hammer were used for drilling the shot holes in which the dynamite charges were placed. The use of an air drill was advantageous as bare rock was exposed in most of the area; a 4-ft. jackhammer hole, 1¾ in. in diameter, could be drilled in less than 2 minutes. With such a drill hole, a small, well-tamped charge of from 2 to 2½ lb. of 45 per cent dynamite sent energy along a 900-ft. spread.

From the 11 spreads, depth data were computed at some 36 points. Such seismic data gave the depth to the high-speed Moenkopi formation. The spreads were arranged to secure a check between the seismically determined depths to this high-speed layer and the depths to the top of the Moenkopi formation as obtained by drilling at seven different drill holes. It was found that the seismic depths agreed with the drill depths within 6.7 ft. on the average. The average depth to the Moenkopi was 143 ft. for these drill holes.

On the basis of the checks noted, however, it could be assumed that the seismic high-velocity horizon was essentially equivalent to the top of the Moenkopi.

Fig. 6—"Subsurface Contours on Buried Channel; Nokai Mesa, Arizona," was prepared from 36 seismic depth measurements and from some 35 core-drill holes. The contours show the course of the channel and give the subsurface elevation of the seismic high-velocity layer where seismic data was used or the elevation of the top of the Moenkopi formation where core drilling was available for subsurface control. These two horizons were essentially one and the same.

This map (Fig. 6) indicates that the channel runs in a southwesterly direction for a distance of about 1,000 ft. from the eastern edge of the mesa where its position is definitely known. The channel then turns sharply southward and its course, as expressed by subsurface contours, can be followed for approximately 1,500 ft. to the edge of the area explored.

Conclusions

The seismic refraction method appeared to be applicable to the problem of tracing buried channels of the type under investigation at Nokai Mesa. In view of the extensive are to be explored back from the rim of a mesa even for a small channel and the fact that core drilling or other forms of drilling are slow and costly at best, the seismic procedure should be advantageous in channel investigations.

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Fig. 1—Lenticular development in Shinarump conglomerate, left center. Wingate sandstone cliffs in background, Wayne County, Utah.

Oil and Uranium—Partners or Competitors?

. . . The geologist, as do we all, has a stake in both

by F. L. Orman

DURING the past 9 years some oil companies have maintained a hands-off attitude toward the uranium industry, some have been indecisive, and others have jumped into uranium work with exploration, mining, and milling programs.

What common interests do the two industries have? What methods and techniques used by the oil industry are applicable to exploration for uranium?

The oil industry has a long history of development of exploration tools, techniques, and interpretation procedures. In the earliest days, a "reason for drilling" was an oil or gas seep. When **direct** evidence diminished, exploration "reasons" were based on **indirect** evidence discovered by surface and subsurface mapping, magnetic, gravity, and seismic surveys. No one tool found a place as the perfect exploration instrument, and none was any more valuable than the ability of the person directing the exploration.

The uranium industry has compressed into little more than 10 years the 50-year history of the oil industry. The direct evidences of mineralization have accounted for most of the discoveries to date. In the future, however, discoveries based on indirect evidence will increase steadily in percentage of total number of discoveries.

Basic Approach to Investigations

The sudden importance of the uranium search has revived an active interest in the basic geologic studies—stratigraphy, tectonics, and mineralogy.

In surface and subsurface stratigraphic studies, extreme accuracy in correlating finely subdivided lithologic units is necessary. Percentage relationships of conglomerates, sands, shales, and mudstones are clues to possible areas of mineralization. Many ore concentrations in sands or conglomerates are directly underlain by a mudstone. The importance of study of sedimentary processes is emphasized in a list of criteria assembled by E. V. Reinhardt and published in "Practical Guides to Uranium Ores on the Colorado Plateau." (See listing Column 1.)

Guides Attributed to Process of Sedimentation

1. Presence of fossil stream channels.
2. Thickening of sandstone lenses.
3. Interfingering of mudstone and sandstone lenses.
4. Presence of carbonaceous material.

Guides Attributed to Postsedimentation Processes

1. Proximity of ore.
2. Relation to mountain masses.
3. Bleaching of sandstone.
4. Bleaching of mudstone adjacent to sandstone lenses.
5. Presence of yellow iron-oxide stains.
6. Presence of bleached mudstone pebbles in sandstone lenses.
7. Etched and corroded sand grains.

Structural configuration of the earth's crust and its relationship, if any, to mineralization in stratified rocks is not clearly understood at this time. The subject is under debate, and it is likely that for every sample of mineralization which appears to be controlled by some structural factor there will be an example showing no relationship to structural features. It is probable that this problem will be resolved on a localized basis.

Mineralogical determinations of field specimens will present the highest hurdle for geologists trained at schools where petroleum studies are emphasized. The "hard rock" courses have resumed a proper position of importance. Many dangers in unskilled use of visual and radiation data in the field must be overcome by experience and diligent study. Recognition of mineral associations, sedimentary host rocks, and evidences of hydrothermal activity will furnish many of the criteria for detecting areas favorable to mineralization.

Other Approaches to Investigation

● Aerial-photograph interpretation, which has developed into a major ex-

ploration tool for the oil industry in the last few years, is one of the most valuable approaches to be made in investigating for radioactive mineralization. Recognized criteria in a particular province must be respected. Often reconnaissance interpretations are supplemented by color and low-altitude photographs.

● Magnetic-survey programs have been revived. Sensitive instrument observations are studied for clues to determine stratigraphic sequences and to delineate intrusive rock.

● Mapping by gravimeter will aid in defining characteristics of basement rocks, and batholithic and laccolithic intrusions. Commercial uranium ores are known near Henry Mountains laccolith.

● Core-drilled footage by government agencies and by private industry has increased tremendously year by year. In addition, it has become the practice of many oil companies making seismic surveys to investigate shot holes for radioactive mineralization.

● Logging of seismic and core holes by gamma-ray tools has become commonplace and today represents the most useful method of rapidly defining zones of mineralization. Many seismic companies have expanded their services to include the uranium industry. A typical log combining gamma-ray and electrical resistivity graphs is shown in Fig. 2.

● Soil analysis and plant analysis are other lines of investigation used in the search for radioactive minerals. The Atomic Energy Commission has granted $5,200 to University of Arizona for research concerning evidence given by floral plants of the presence of uranium.

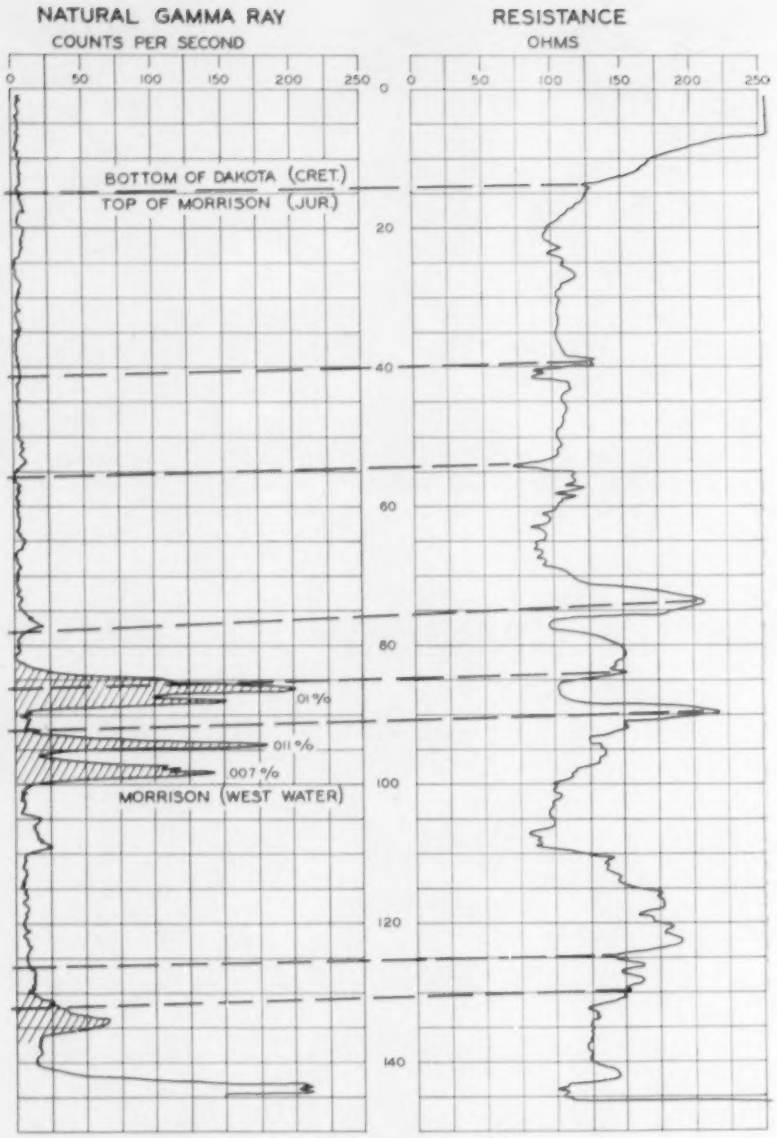

Fig. 2—Typical radioactivity-electrical resistivity log in New Mexico portion of Colorado Plateau. (Log courtesy Century Geophysical Corp.)

Industry Relationships

Since the oil industry has this wealth of exploration tools and know-how, is there any reason to be reluctant about beginning a program of exploration for radioactive ores?

The oil industry had a temporary subconscious fear that, presto, nuclear energy would become a substitute for petroleum energy. Actually, the potential benefit to mankind is so vast that it is impossible to envision the ultimate good that will obtain. Today the oil industry is only beginning to visualize the full significance of oil and gas as a raw product. Oil and gas can now be regarded as more than just an extractive mineral. Scientific inquiry and millions of dollars are being dedicated to research in petrochemistry. Today there are 500,000 products with petrochemical components, and it is visualized that before long there will be more than a million products which contain petrochemical components.

Raw materials are not limitless. As a matter of fact, the first half of the twentieth century may be remembered as the "Period of Great Waste"—when hydrocarbons were withdrawn from the ground and used directly as fuels.

Conclusion

The potential replacement of petroleum as propelling energy need cause no fear in the oil industry. Rather the oil industry should assemble the best elements of exploration knowledge, equipment and research studies and embark on an aggressive program of search for and refinement of radioactive ores. At the instant security restrictions on atomic energy data are relaxed, the oil industry must be ready to welcome the uranium industry as a full-fledged partner in a free-enterprise economy.

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Fig. 1—Field prospecting party examines a surface radioactive anomaly on the Navajo Indian Reservation, Arizona.

Fig. 2—Reconnaissance field parties on the Colorado Plateau operate from tent camps such as this.

THE GREAT AMERICAN SPORT—1955 VERSION

"You Just Can't Lose"

. . . *Practically everybody's looking for uranium*

by R. Maurice Tripp

THE search for commercial quantities and concentrations of uranium-bearing minerals has caught the fancy and fired the enthusiasm of the American public. It is not the intention of this discussion to delve into the philosophical and psychological reasons for this mass excitement over prospecting. A great deal of it doesn't make sense when viewed in the cold light of probable economic returns. This is particularly true in case of the vacation prospector and weekend uranium hunter.

Truly, uranium hunting has become the great American outdoor sport, to be talked about and participated in by high-school lads, shoe salesmen, milkmen, insurance agents, carpenters, machinists, college students, woodsmen, geologists, petroleum engineers, Sunday-school superintendents, bankers, cooks, diplomats, secretaries, draftsmen, electricians, and executives. The inspiration of each may be different and the excuses for their ventures may run a longer gamut than the types of people themselves; but the objective is similar, to find a uranium mine and make a million dollars.

A million-dollar discovery for every prospector (Fig. 1) may be statistically unrealistic, but the national and international publicity which has grown around such discoveries as that of Vernon Pick's Delta mine and Charlie Steen's Mi Vida mine has been proof enough to many people that if they can get to Grand Junction, Colo., on their vacation and stake a claim on an outcrop of the Salt Wash sandstone or Shinarump conglomerate (even if they can't pronounce it) that they are in the uranium business and destined to make a million dollars. Furthermore, they do not even need to know what a uranium mineral looks like or which rocks contain uranium minerals. Life magazine clearly pointed out that the Atomic Energy Commission staff will tell them where to go and any drug store or filling station in town will sell them a geiger counter with instructions on operation.

You just can't lose! A Salt Lake paper carried an ad by an enterprising real-estate dealer offering a free geiger counter to each new house purchaser. Why isn't everyone looking for uranium? The truth is that they practically are. At least, it seems so when looking for a spot of unstaked ground on the 150,000 sq. miles of the Colorado Plateau. Last spring one of the counties in southeastern Utah reported that there was a cumulative total acreage on which claims had been filed that exceeded the total area in the county by 200,000 acres.

All of this is very interesting and sometimes amusing. But between chuckles one is reminded that America urgently needs every pound of uranium that can be found and produced by vacationer, prospector, geologist, hard-rock miner, or oil company, and it is needed in a hurry.

U. S. requirements . . . A great deal has been said and written during the last several months about the uranium raw-material requirements of the United States. Some statements indicate that we are facing a desperate situation of uranium starvation and that the AEC is going to take drastic measures to obtain more foreign ore. Other statements imply that there is already over-production and the only thing that keeps most mines open is the AEC's guaranteed purchase price until 1962. Exactly where the truth lies between these extremes we don't know. We **do** know that uranium has at least two important consumers that are pretty firm. The first is the military and we neither know nor can talk about the magnitude of their requirement. The other consumer is the United States industrial power-generating plants.

Source of industrial power . . . At the rate at which industrial power-generat-

ing capacity in the United States is expanding, not considering any growth in the adjoining areas of Latin America, it will be necessary to build 300,000,000 kw. of new capacity during the next 30 years. This is three times the total present United States capacity. The coal and natural-gas industries cannot economically expand rapidly enough to meet this fuel demand Nuclear fuels can supplement coal and natural gas to help relieve the strain to the extent of perhaps 20 or 30 per cent of the total.

But even when considering reasonable improvement in nuclear power-plant technology, it is unlikely that the relative fixed costs involved of producing electric power from nuclear fuels and fossil fuels will tolerate reactor power plants in more than one-third of all new installations. The higher cost of the power produced by nuclear reactors as compared to coal-burning plants results mostly from amortization of the much larger capital investment in the generating plant and not in the relative costs of fuel.

A radical departure from the present scheme of using the fission reaction as a source of heat to fire boilers and run turbines might alter these considerations. But there are no good prospects for a more efficient process on the immediate horizon.

In other words, neglecting the military program and peacetime uses other than the expansion in industrial power-producing facilities and figuring that it requires 50 tons of uranium metal to produce a million kilowatts of electric energy annually, we are talking about burning a total of 5,000 tons of metal per year. The average grade of ore coming from the Colorado Plateau is about 0.25 per cent U_3O_8. Using this figure we would require an annual production of approximately 2,500,000 tons of ore. This would only meet one-third of the fuel requirements for new power-generating plants to be built in the United States during the next 25 to 30 years; it would be a 25 per cent increase over the reported total United States uranium production in 1954, or one-fourth of the entire production of the free world last year*

Fig. 3—The rugged terrain of the Colorado Plateau forces prospectors to use jeeps and other four-wheel-drive vehicles. These crews are equipped with a high-pressure ionization chamber for making a continuous record of gamma ray intensities.

These figures are pertinent for two reasons:

1. They point out that the production of uranium ores and concentrates for peacetime uses is destined to grow into a significantly important industry.

2. The present rate of production of uranium ores is inadequate and the total known reserves must be expanded many fold to satisfy the conservatively estimated nonmilitary future demands.

Known reserves . . . Let us take a look at the current known reserves picture. There are approximately 700 to 800 uranium mines on the Colorado Plateau. Their average size is somewhere in the neighborhood of 5,000 tons and there are probably not over 12 or 15 mines whose known reserves exceed 100,000 tons. Furthermore, it is significant to observe that most of the ore bodies found so far either outcrop or are very near the surface. In fact, in certain well-developed districts along the Uravan mineral belt, the number

*It appears that the production of nuclear fuels is going to have a hard time increasing fast enough to relieve a consequential amount of the strain in the fossil fuel expansion requirements for industrial power in the U. S. alone during the next 25 to 30 years, and that it certainly won't be competitive with petroleum. In fact, only about 3 per cent to 4 per cent of petroleum fuel goes into the production of industrial power in the first place.

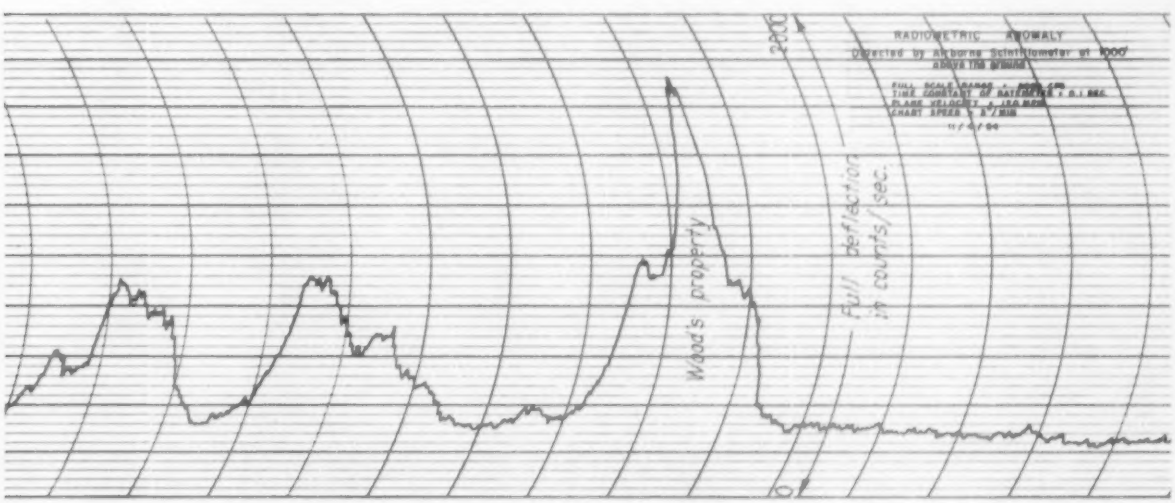

Fig. 4—Airborne radioactive surveys have resulted in the discovery of many ore bodies and are extremely effective in guiding ground reconnaissance surveys.

of mines per square mile is proportional to the linear miles of outcrop of the Salt Wash sandstone per square mile. (Fig. 3).

In areas where the erosional dissection of the host rock has not provided visual access into the potential ore horizon, synthetic outcrops have often been provided by diamond drill core holes. This procedure is expensive and not too conclusive because of the restricted size of many ore bodies and the rapid lateral change in the lithology of the uranium host rock. Important ore bodies have later been found in previously abandoned areas that had been drilled on 50-ft. centers.

It is also pertinent that there have not been any new discoveries of major-sized uranium ore bodies in the last 2 years. The rapid increase in reserves has resulted from extensions of known ore bodies and outpost drilling near known ore, and the finding of a large number of small deposits.

The conclusion which can be drawn from these observations is that more definitive exploration techniques are needed than can be provided by a geiger counter and the squinting eye of a prospector if the indicated minimum uranium production is to be reached. Furthermore, the projected size and probable rate of growth of the new industry is large enough to warrant spending time and money on the development of better exploration methods.*

Fig. 5—Lab facilities are necessary for determining the trace element content of plant or soil samples.

Uranium Prospecting

The philosophy of exploration for uranium is not greatly different from that of any other mineral even though field details may vary some. Much work has been done, or sponsored with outside agencies, by the AEC and the U.S.G.S. in developing effective field techniques and several private companies have carried on considerable research along these lines. The following discussion is not intended to be an exhaustive or detailed account of field procedures, but only a general review of some of the thinking and examples of how they are implemented.

Two approaches . . . There are two ways to begin a program of mineral exploration, one is strictly empirical and the other is imaginative. The first requires a broad working familiarity with all conventional exploration methods and techniques. The latter requires, in addition, a detailed knowledge of the basic factors underlying the geologic processes of ore localization, a bold imagination, and lots of practical resourcefulness. The first approach appraises the physical and chemical prop-

*The U. S. government has already spent or has committed to spend approximately 14 billion dollars on facilities which are dependent upon the availability of ample supplies of fissionable raw materials. The reserves must be found and produced.

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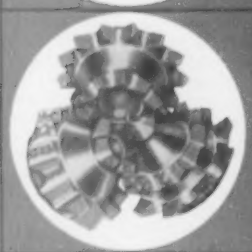

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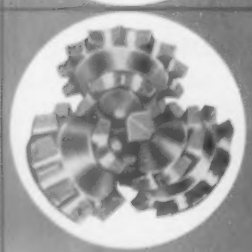

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erties of the mineral sought and any associated minerals, as well as the host rock in the zone of mineralization and at a distance therefrom. Then, measure the diagnostic property over barren ground and mineralized ground and see if a recognizable anomaly in that property exists over an ore body and if there are other features having nothing to do with mineralization that might yield similar results.

The second approach requires the formulation of an hypothesis concerning the geological processes governing the formation of the mineral deposit and then designing of suitable geophysical and/or geochemical techniques to confirm or disprove the hypothesis. Application of the method is straightforward. No more decisions or evaluations must be made. If the experimental results indicate the hypothesis is confirmed, the next phase of the work, such as core drilling, proceeds automatically.

The outstanding advantage to this procedure is that it is possible to postulate the conclusions which would be reached for each of the possible combinations of field results **before** the field work is performed. If the conclusions which are possible aren't valuable in helping to define a mineral deposit, then the hypothesis is not a pertinent one and the plan should be altered before unproductive work is performed.

A blending of these two philosophies in designing a uranium-exploration program is probably the best procedure. The result is a series of field investigations which may be divided into three broad classes:

1. The direct detection of gamma-rays with geiger counters, scintillometers, or ionization chambers.

2. The search for and delineating of a geological environment which is known from past experience to have a high incidence of ore, such as scour channels in the Moenkopi shale which have been filled with Shinarump conglomerate.

3. The detection and mapping of an abnormality in the composition or structure of the country rock which may have resulted from the invasion of mineralizing solutions into the local area. Examples might be secondary cementation, leaching, clay-mineral formation, fracturing, faulting, trace-element redistribution, or high sedimentational permeability.

Direct detection . . . The first class of measurements is exceedingly popular even though their significance is poorly understood and sometimes misleading. A generally accepted fallacy implies that uranium emits gamma-rays, which it does not. The presence of uranium can only be detected by a gamma-ray-sensitive device when some of the uranium's gamma-emitting daughters are present with it. If the mineral deposit is seriously out of equilibrium because of selective leaching or precipitation by the ground water, there may be no increase in gamma intensity above background and yet there may still be a very rich uranium deposit in the vicinity. Or there may be an extremely high

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R. Maurice Tripp, consultant, Dallas, was born in Holton, Kans., in 1916. He was educated as a geological engineer at Colorado School of Mines and later did graduate work and teaching in geophysics and geochemistry there before receiving his Sc.D. in geology from M.I.T. Dr. Tripp has been involved with mineral-exploration problems in various parts of the world. His principal activities are concerned with the research and development of new methods of exploration for minerals. He is the author of numerous technical papers on special methods of exploration and is a member of several professional societies.

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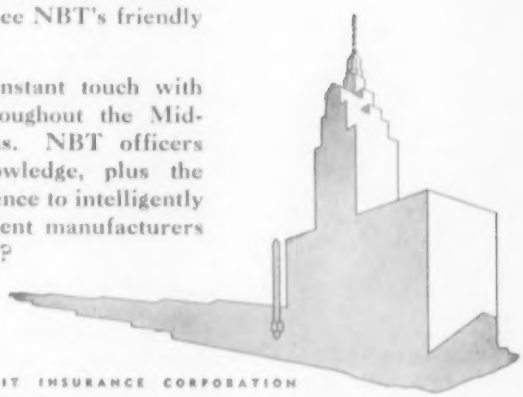

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gamma intensity coming from an outcrop which yields lots of radium but no uranium on assay.

Geiger counters and scintillometers indicate the passage of so many gamma rays per unit of time through their sensitive volumes. Most geiger counters have a detection efficiency (often called sensitivity) around 1 per cent and scintillometers may recognize as high as 25 to 50 per cent of the gammas which pass through them. Neither is able to detect the low-energy gammas. Ionization chambers measure the **total energy** of the radiation passing through them rather than the number of events, and they can be made sensitive to very soft as well as to very hard radiation and, at the same time, preserve a detection efficiency approaching 100 per cent. They cannot be made with a fast time constant comparable to scintillometers.

Each prospector swears by or swears at the particular instrument he uses and is convinced that certain instruments "penetrate" deeper than others. The truth is that the gamma-rays do all the penetrating and not too much at that. One or two feet of normal rock and soil will absorb better than 99 per cent of the gammas from uranium in equilibrium. The detecting device has no influence on this property. It can only recognize those gammas which reach its sensitive volume.

Counters, scintillometers, and ionization chambers may be carried by hand from one point of interest to another; they are transported by jeep with or without facilities for continuously recording the gamma intensity over the route traversed; and they are mounted in planes which may fly along the outcrop of a likely ore-bearing formation or fly a controlled grid pattern. In the latter case, there is nearly always a continuous record made of the data. (Fig. 4). Specially designed units or logging devices make vertical excursions into drill holes with and without recording facilities.

Recognizable radiometric anomalies have been observed above ore bodies as deep as 500 ft. below the surface. This is explained by the fact that the ratio of annual precipitation to evaporation in the area is 0.15 and that the net motion of ground water is vertically upward from the water table to the surface. A few ions of the radio elements are dissolved by the upward moving water when it passes the ore zone, and they are carried to the surface and precipitated upon evaporation of the vadose water. This is the source of gammas detected by surface instruments.

Geophysical methods . . . The second classification includes such procedures as regional magnetic and gravity surveys to define tectonically active areas, and seismic and magnetic methods to locate the course of ancient stream scour channels. It has been observed that there is a higher incidence of mineralization in the coarse sand and conglomerate filling the scours in the Shinarump and Salt Wash than in the formation generally. The scours may range in depth from 1 to 40 ft. and be 100 to a couple of thousand feet in width.

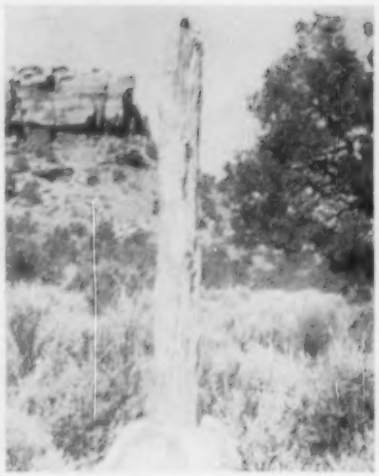


Fig. 6—Claim discovery monuments dot the Colorado Plateau.

Seismic refraction methods and high-frequency reflection methods have been used successfully in many places to map these channel depressions. The depth to the refracting or reflecting interface may be 40 to 400 ft., but sometimes there is no sharp velocity discontinuity at the formational interface. A modified refraction scheme based on the Blondeau theorem has been employed under these conditions.

The basic premise is that the nature of the sediments in a channel fill will differ from the flanking sediments because of grain size, degree of sorting, presence of extraneous debris, orientation of particles along streaming lines, and so forth, and that the vertical velocity gradient of a sediment will be influenced by these factors. Therefore, the rate of increase of seismic velocity with depth will vary laterally when crossing a channel fill.

Some slight success has been achieved in mapping the course of channels by magnetic methods when the depth to the channel was less than 50 ft. and the topographic surface was nearly parallel to the stratigraphic horizon of the channel. The increase in heavy-mineral content along the channel way may account for the small increase in vertical magnetic field intensity.

Other prospecting methods . . . The third class of methods includes such techniques as color air photography to localize alteration zones resulting from hydrothermal action and the mapping of areas of increased fracture pattern frequency. All the variants of trace-element techniques belong here along with the botanical sampling and mapping. The fundamental hypothesis for geochemical methods is that the path along which mineral-bearing solutions moved, which invaded the country rock, can be recognized because:

1. Certain trace elements which are normally indigenous to the formation are selectively leached away or depleted.

2. Other trace elements or minerals not originally present in the rock or only there in small amounts will be introduced or enriched.

3. That minerals originally present will be altered to new minerals without depletion or enrichment.

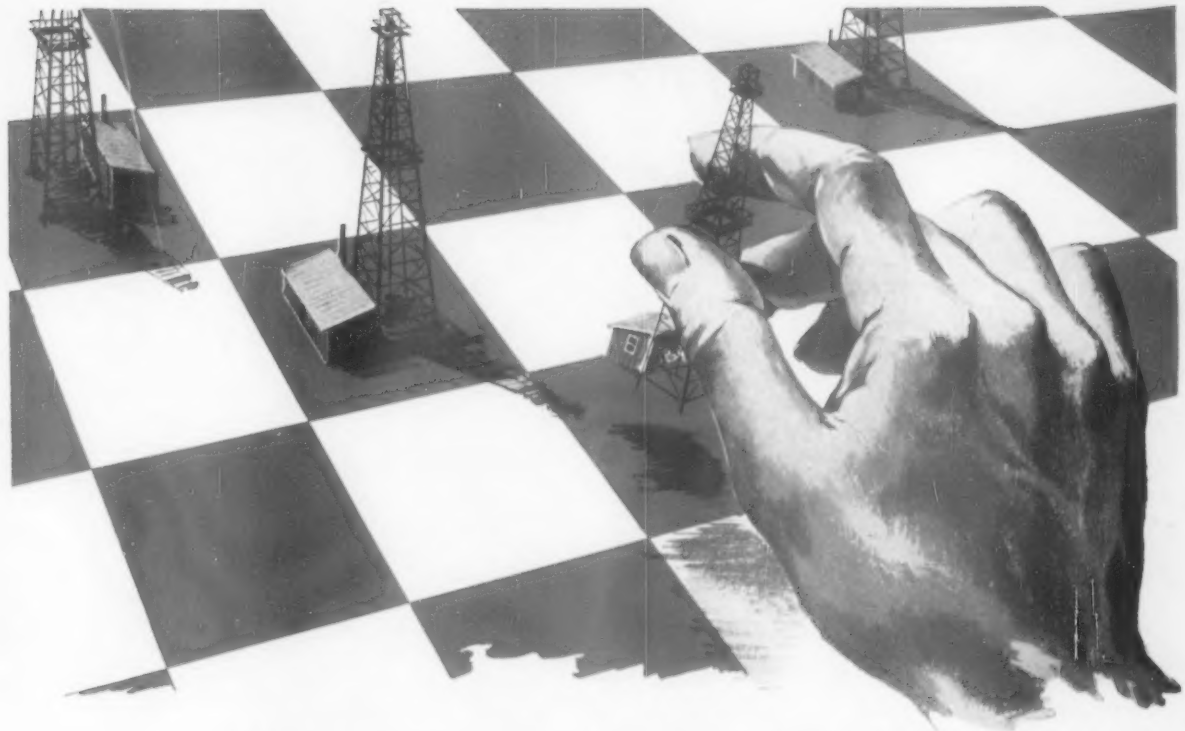
In all cases, it is assumed that if the conduit along which the mineral-bearing solutions migrated can be located, any ore bodies will lie somewhere along that conduit and the search is narrowed.

It makes no real difference whether a sample of rock or soil is collected for micro assaying or whether the gathering system of plant roots is used to collect a more representative sample over a long period of time and then some portion of the plant is analyzed (Fig. 5). Some prospectors even feel that the very presence of a given plant species is sufficient evidence to indicate an abnormal concentration of a particular diagnostic element.

Magnetic methods are sometimes used to define areas which have been subjected to hydrothermal action because of the tendency to preferentially leach the minerals with high magnetic susceptibility. Seismic refraction techniques like the modified Blondeau method already described are sensitive to the recognition of alteration zones as well as to structural anomalies.

Electrical methods have been useful in logging drill holes and interpreting lithology therefrom without the necessity of recovering a core. Special techniques have been developed whereby resistivity and self-potential logs can be obtained from holes that have been drilled dry. In some areas there is a sharp resistivity high at the top of the mineralized zone and surface resistivity techniques have been able to "recognize" mineralized ground.

Self-potential methods of surface mapping have been difficult to impossible over most of the plateau because of the deep water table and the lack of ionic conduction near the surface. This has limited the application of all galvanic electrical methods which otherwise might have been effective.



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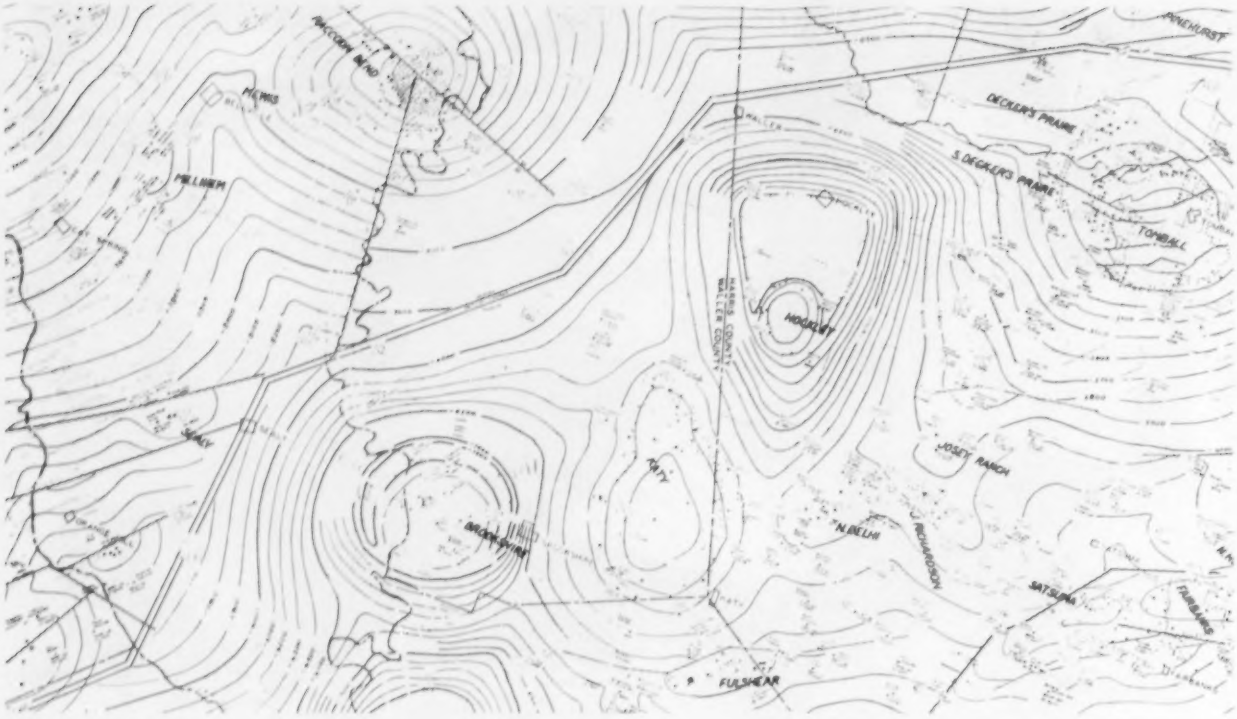


Regional Subsurface Maps Reveal

The High and Low of It

by Russell F. Klinger

A REGIONAL subsurface map should be the basis of all exploratory effort for any oil company which actively seeks new production through its own program. With this tool the larger companies lay out their geophysical, leasing, and drilling programs. The smaller companies who rely, at least in part, on drilling submissions from outside sources can use the regional map in much the same manner.

A portrait of trends . . . A regional subsurface map is a respository for all available geological data in a given broad area. When these data are intelligently interpreted by trained geologists, the map becomes a portrait delineating structural trends—the highs and the lows—within the area covered. The use of this map for guidance in exploratory effort is then available to the geologists and management. It should be used as the determining factor in the choice of areas or zones of probability in which productive structures may be found. Similarly, the map points out negative areas where structures are less likely to be found.

Armed with this exploratory tool any company can upgrade the quality of prospective areas which it drills by virtue of being able to select only those areas within zones of probability.

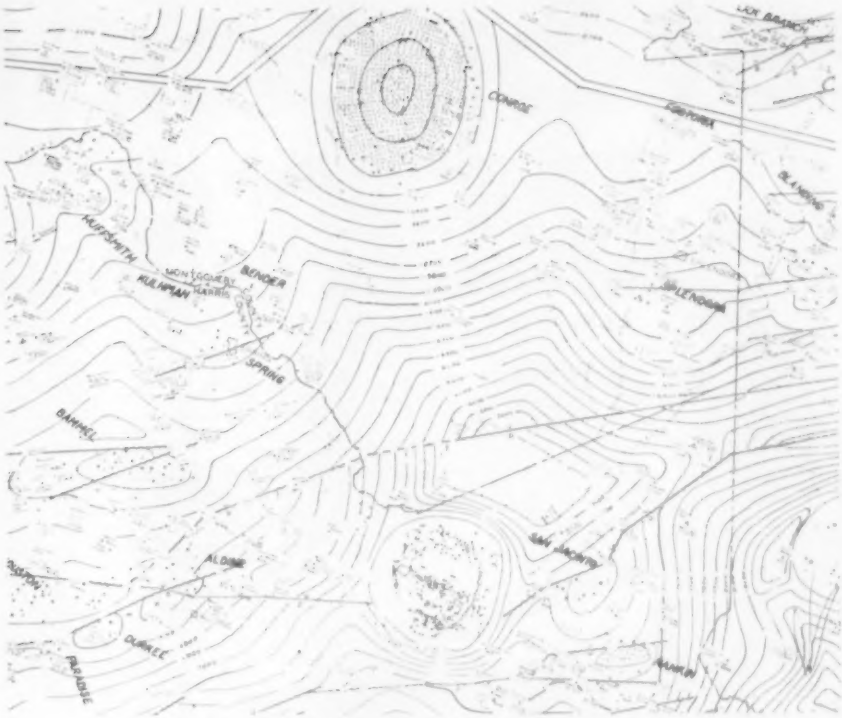
Zones of probability . . . The zones of probability as referred to above are those areas within the structural trend along the axis of the anticlinal folds. The structural trends of the Upper Texas Gulf Coast usually have a northwest-southeast axis of folding. Since these folds are roughly normal to the regional strike, they may be referred to as crossfolds. The term crossfold applies to only the anticlinal trends and not to the synclinal areas. Excluding the salt domes, either piercement or deep seated, almost all of the productive structures are located along the axis of the crossfolds. Trends along the axis of cross-synclines yield few, if any, fields.

The zones of probability then may be defined as that zone along the axis of a crossfold where only one major unproven structural condition need be verified to form an effective oil trap since within the zone of probability, dip in three directions already exists. Generally, the one unproven condition occurs in the form of a fault crossing the axis of the crossfold or perhaps reversal of dip.

The farther you move away from the axis of the crossfold, the more unusual the unproven conditions must be verified to form a closed structure. On the flank of the crossfold, at least two conditions must be satisfied and in the synclinal areas, three and possibly four unproven structural conditions must coincide.

The companies which drill near the axis of crossfolds—the zones of probability—should have a high discovery ratio. The companies which choose to gamble on two to four structural unknowns will suffer many disappointments.

Of all the new-field wildcat locations drilled last year in the Upper Texas Gulf Coast, over 70 per cent of them were drilled outside of the zone of probability with at least two structural conditions to satisfy and every one of them were



Regional subsurface maps such as this become a portrait of structural trends when accorded proper interpretation. (Courtesy Coastal Geological Service, Houston.)

dry holes. Of those wells drilled within the most favorable zone of probability, one out of every four produced.

Regional maps vital . . . If placing well locations within the zone of probability leads to better production odds, then why do companies locate wells outside of the preferred zone?

The first and most obvious reason is that outside of the large major companies, only a relative handful of companies maintain adequate regional subsurface maps. The initial cost of good maps, plus the time element in maintaining them, discourages many smaller companies with limited geological staffs from using this tool. Without regional maps these companies have no direct means of considering the location of their prospects with relation to regional structure.

The second reason is the lack of appreciation by many people of the true usefulness of the regional map.

This kind of people are found in nearly all companies.

Experience counts . . . The value of the regional subsurface map increases as the experience of the geologist increases. Yet in many cases, work on the regional map is used to acquaint the beginning geologist with the geography of the area. When he becomes generally familiar with the stratigraphic and structural aspects of his area, he is then ready to assume fuller administrative responsibilities. To yield the full benefits, regional subsurface mapping should be done on a full-time basis with trained geologists.

A trained geologist has a store of knowledge which may be referred to as comparative geology. It is a working knowledge of not only the stratigraphic and structural conditions as they are known to exist today, but also an awareness of the changing conditions of the past which led to the present thinking. This type of knowledge permits projection of geologic ideas from areas of maximum subsurface control to areas where little drilling has been done. This enables him to set up new prospective areas for further exploration.

To find new pools . . . The regional map has been called a portrait of structural trends, but it is more definite.

Regional subsurface work is an excellent means of determining the possibilities of extensions to presently productive fields. As an example, if you should find a field along the axis of a crossfold whose size seems disproportionately small to the over-all width of the crossfold, it would suggest a closer examination for additional fault segments along the axis of the productive structure.

Regional work not only carries the known fault trends, but many times points up heretofore unsuspected zones of faulting which may very well lead to new areas for immediate further exploration.

And strand lines . . . Stratigraphic studies in connection with regional work give clues to strand-line plays. These studies also give the geologist the necessary background for outer flank salt-dome sand pinchout plays.

In short, the regional subsurface map is the most versatile of our exploration tools.

Of course, the regional map also has its weakness, which is the inherent weakness of most exploration tools. Its strength or weakness lies in part in the amount of well data available in any area. Subsurface mapping is really structure - forecasting, and just like weather forecasting, it is limited by the availability of basic data. But even though the weather forecaster is frequently wrong, no airline would think of operating without the best weather information obtainable. The user must judge for himself the adequacy of control in any given area just as a pilot must judge how far to rely on a weather map. Most parts of the Gulf Coast have been drilled to a density which now permits effective regional mapping and good, reliable structural forecasting.

New fields to find . . . In watching and working with the geological developments of the Upper Texas Gulf Coast area, it is apparent that there are many sizable oil pools yet to be drilled. Since World War II significant oil and gas reserves have been added from extensions to known fields and from outer flank plays on salt domes. These plays will continue to occupy a good share of the exploration budgets. But there is still room for the real wildcatter who wants a structure all of his own. So find yourself a crossfold and run it down. That is the high and the low of it.

THE AUTHOR

Russell F. Klinger is manager of Coastal Geological Service in charge of regional subsurface mapping. He graduated in geology at Lehigh University in 1942 and immediately entered the Navy. After 3 years in the European area he left the Navy as a full lieutenant in 1946 and entered the geological department of Stanolind Oil & Gas Co. in Houston. He spent 7 years with Stanolind, the last 3 as district geologist in charge of the Houston district.

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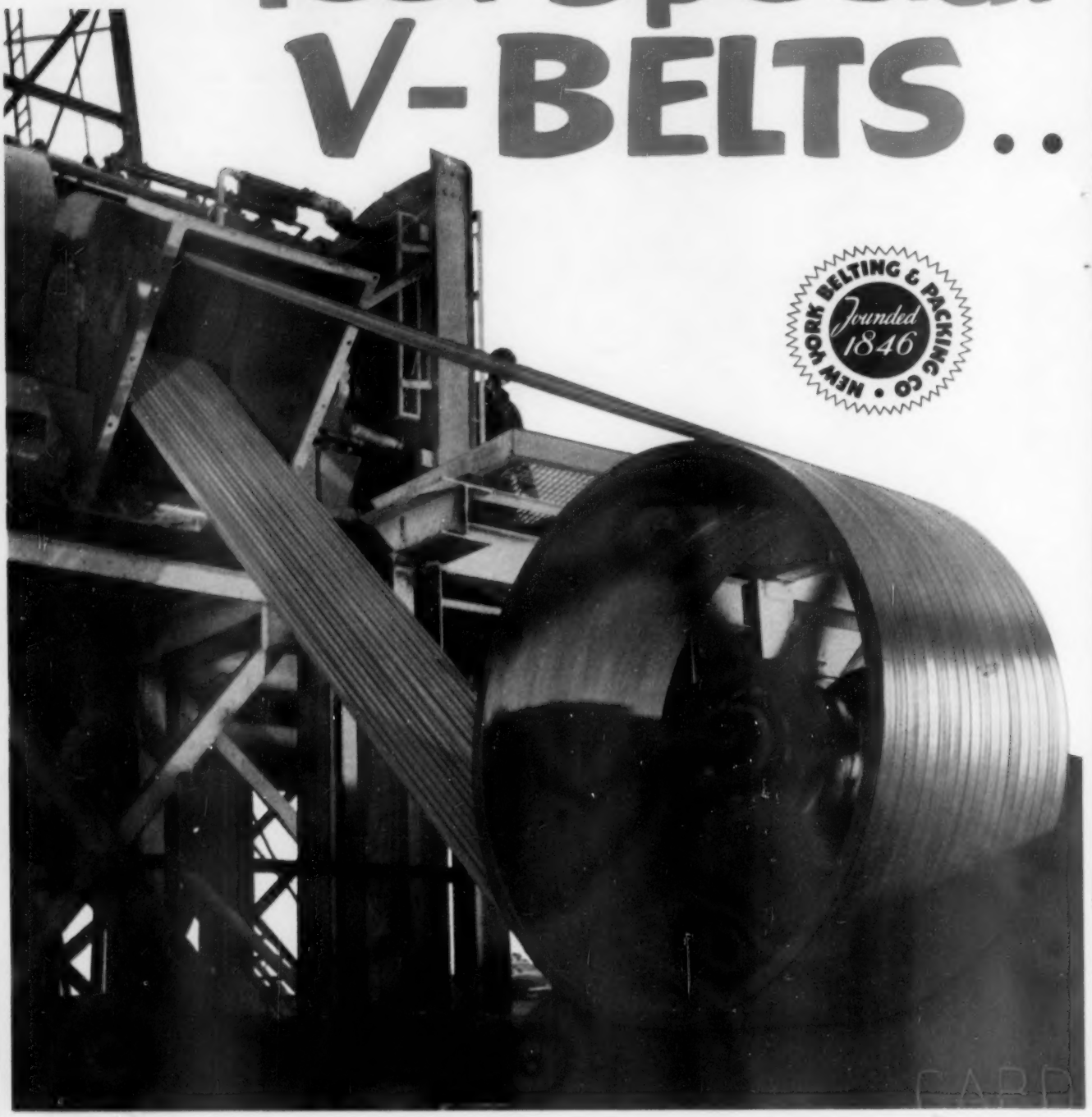

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SYMPOSIUM . . .

Magnetic Recording—New Tool In Seismic Prospecting

The Geophysical Society of Tulsa recently held a symposium on Magnetic Tape Recording with W. T. Born, Geophysical Research Corp., Tulsa, as the moderator. Here are abstracts of the papers presented. J. D. Skelton's survey of Geophysical Type Magnetic Tape Recorders is presented in full.

THE AUTHORS

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Supervisor, equipment section, Continental, Ponca City.

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Senior research engineer, Stanolind, Tulsa.

J. H. HIDY

Research engineer, Seismograph Service Corp., Tulsa.

Introduction

by W. T. Born

BY presenting a symposium on the application of magnetic recording to seismic prospecting, the Tulsa Geophysical Society gave recognition to the growing importance of a new tool in the kit of the seismic prospector. The usefulness of a seismic record produced in a form which permits the seismic signal to be reproduced at will, has been recognized for a very long time. The rapid development of the techniques of magnetic recording during the past few years has made it possible to obtain such records easily and in a satisfactory form. At the present time a number of satisfactory magnetic recorders, especially designed for use in seismic surveying, are commercially available.

The value of any new tool lies in the use which may be made of it. Magnetic recording is not, of itself, a new technique of seismic surveying. Intelligent use of the reproducible records now obtainable may reasonably be expected to produce considerable improvement in the existing techniques of seismic surveying; such use may possible lead to the practical development of techniques hitherto thought impossible or impractical. The availability of a new tool, and data obtained by its use, very often give an impetus to creative thinking. It may well prove true that the greatest future value of magnetically recorded seismic records lies in an application as yet unknown.

Magnetic Recording in Field Operations

by H. R. Frank

IN field operations Continental Oil Co. uses magnetic recorder-reproducer systems. These units are used for routine recording operations on some crews and also in conjunction with field service units to supply playback facilities when needed on other company crews and contract crews.

Only minor problems have been encountered in the use of magnetic recorders in field operation. There have been no indications that playback records are appreciably affected by dust, static charges, or dropouts. The stability and reliability of the magnetic units has been comparable with that of conventional recording units. The training of operators has not been a problem, due to the incorporation of suitable control devices on the recorders which make the operation rather simple. No extra personnel have been added to crews using magnetic recorders in routine operations.

It is believed that the magnetic recorder is a practical field tool and a definite aid to improving seismic results.

The minimum routine field use of the magnetic recorders includes the following:

1. Every shot is recorded unmixed through a broad-band filter on magnetic tape, and a monitor record is simultaneously recorded both mixed and unmixed on film.

2. The operator immediately plays back the tape through the filter and mixing schemes which have been selected as optimum for the area, plus simultaneously recording an unmixed record.

3. The operator continually checks the frequency content of the broad-band record; approximately once each day he replays one of the shots through a different filter which, in his opinion, might improve the signal-to-noise ratio. If the additional replay should show improvement, recent records are played back through the new filter selection; these records are computed and checked for improvement of record ties and correlation.

4. All shots on magnetic tapes are filed for future use in the event of improved instrumentation or a change of geologic concepts as a result of additional information gained through drilling programs.

Some special field uses of the magnetic recorders are as follows:

1. In areas where the frequency content of the reflected events varies considerably on the record, it is routine practice to replay the record through more than one filter.

2. On starting new projects the magnetic recorders are very helpful in determining the optimum equipment settings with a minimum number of shots.

3. In areas where weathering and elevation differences result in abnormal moveouts which are incompatible with the spread length and the amount of phase discrimination (mixing) desired,

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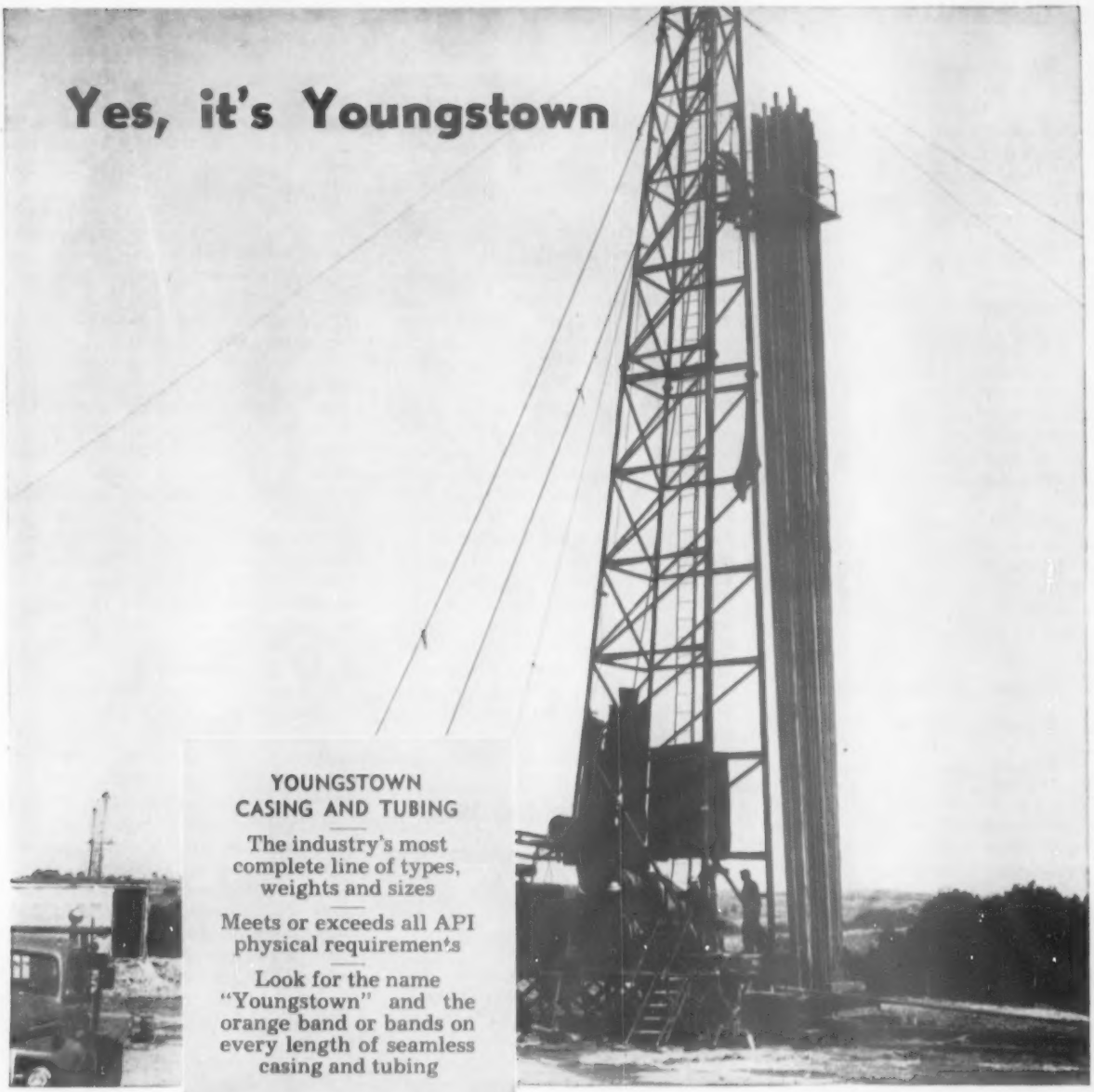

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the head-shifting feature provided on these magnetic units is utilized for making individual trace corrections. Of course, shorter spreads or less mixing could be used to avoid the possibility of "trough-jumping." However, the economic aspect justifies the additional cost of providing magnetic recorders with movable heads and allows maintenance of maximum spread lengths and optimum phase discrimination. This becomes particularly true in areas where high permit fees are being paid for shot locations.

4. In order to provide sharper filter cutoff rates than are present on conventional recording units, the shot may be recorded through a filter on magnetic tape and then replayed through a filter; thus producing the effect of a cascaded filter on the playback record.

5. The use of magnetic recorders in conjunction with the field service units has proved invaluable in helping contractors as well as company-owned crews to arrive at optimum equipment settings.

Display of Magnetically Recorded Seismic Data

by Charles F. Hadley

THE use of magnetic recording of seismic information in the field has brought about problems in displaying the magnetically recorded seismic data in some useful form. The magnetically recorded seismic data has to be converted to a visual record of some type.

The use of photographic oscillograph can be made more convenient by the use of improved photographic developing techniques. One company has applied the Polaroid Land camera to a galvanometer oscillograph. Another type of display offered to the industry is the use of a fluorescent screen to obtain a temporary seismograph record.

Recently, a display has been developed using pen motors for monitoring field seismic records. In this system, a drum carrying electrical recording-type paper rotates on the same shaft as a magnetic drum recorder. The seismic data are recorded on the drum and with a single pen motor carrying an electrode bearing on electrical paper, one trace at a time is played back.

A recorder employing electrically sensitive paper was developed at the Stanolind Research Center using an entirely different principle of operation. This recorder is called the Electrograph. A number of wire brushes are mounted around the periphery of a rotating disk. The brushes are drawn in contact across the surface of the paper in the direction perpendicular to the motion of the paper. The paper is formed into a section of the cylinder by a platen underneath the paper. The signal to be recorded is converted into a time pulse modulated signal. This time pulse is then amplified to a high enough level to mark the paper and then applied to the paper through the rotating brush. As the brushes traverse across the paper, the brush will draw a line consisting of closely spaced series of dots.

This general method of recording can be extended to a multitrace recorder by the employment of a rapid electronic switching system or multiplexing system. In this system, a brush is used many times as it travels across the recording paper. Each trace is formed by 2500 dots per second. The fourteen traces are recorded on a 4-in. width of teledeltos paper. The low frequency response of the recorder is down 3 db. at 3.5 cycles per second. The maximum useful high frequency response is limited by a minimum number of dots which will adequately describe a trace. With the pulse repetition rate of 2,500 dots per second, a 200-cycle per second wave can be reproduced satisfactorily. Timing lines are recorded simultaneously by forming a burst of pulses whose initiation is determined by the timing signal. An electronic counting system widens fifth and tenth lines.

Improving Signal to Noise Ratio by Compositing Magnetic Records

by John H. Hidy

RECENT developments in magnetic recording techniques have provided instruments suitable for use in seismic exploration. These instruments, in their various forms, are capable of recording, storing, and reading out a vast amount of information.

The ease of storage and reproducibility of seismic signals has given rise to a number of novel methods and procedures whereby the quality of seismic records may be improved; in many cases tape recording permits seismic exploration to be used in areas where the signal is so submerged in noise as to be unidentifiable or the return energy too small to be useful.

Magnetic tape recording can produce a number of individual seismic recordings; in these the time relationships of the reflected events are substantially unchanged, except for constant known time differentials, such as geophone position-shot point relationship variations of the low velocity zone; but in these reproductions the amplitude and phase of the noise energy at corresponding geophone positions is random. If algebraic superposition, or compositing, of the various recordings at corresponding geophone positions is done and corrections applied for the time differentials, a new record may be produced; in the new record the signals are added algebraically and the noise added statistically.

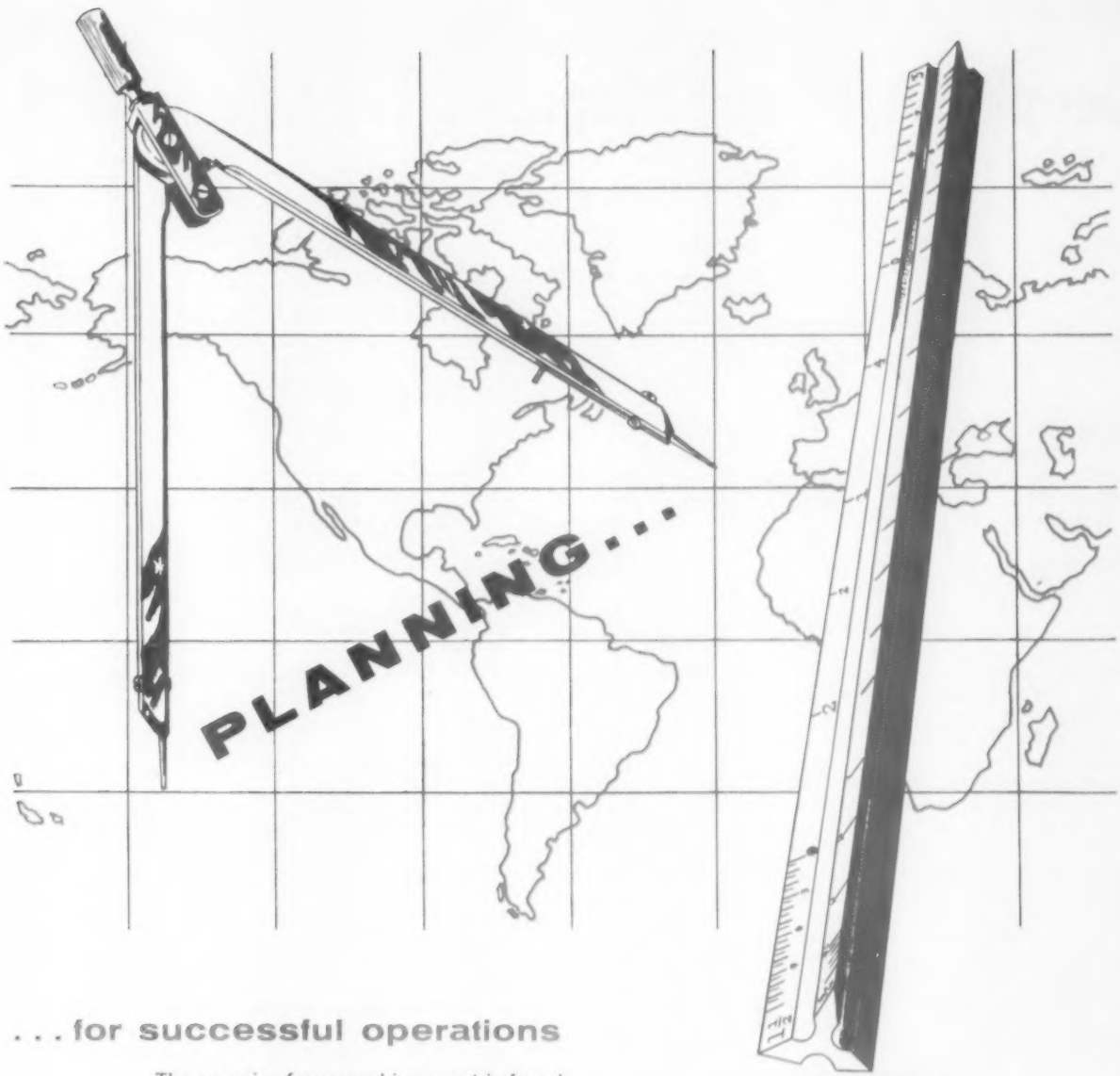
These seismic records with constant reflection time waveform relationship but with noise energy at corresponding geophone positions random from recording to recording may be made by (1) changing from one geophone array to another with explosions detonated in the same hole, (2) by changing from one drill hole to another with the geophone positions remaining fixed or (3) by detonating explosions at different depths in the same hole with the geophone array remaining fixed.

To obtain the desired results from compositing seismic signals, it is imperative that the process of recording and reading of the data should not introduce time distortion between any of the signals to be composited; in addition the instrument must be capable of simultaneously reproducing at least four separate recordings.

Elsewhere in this issue is a description of some excellent recording instruments, some of which might be suitable for compositing is associated with the proper amplifiers and switching circuits. (See J. D. Skelton's article on page 176).

At the time experimentation on the improvement of noise to signal ratio in seismic exploration first started, there were no suitable recorders; it was necessary to construct one to meet the requirements of the methods. This resulted in the construction of a single deck of 12 recording heads spaced angularly around 360° and radially adjusted on 1/10-in. centers with a maximum diameter of 11-½ in. using a 12-in. iron oxide coated disk for the recording medium. A synchronous motor and tooth-belted speed-reduction system were used to drive the turntable at constant angular velocity. This unit was used to record the signals in the field.

Once recorded, the disks were played back on a laboratory magnetic reproducer which was made up in four decks of heads arranged exactly like the field recorder. Each of these decks held a disk and all driven from a common drive shaft. Since, on playback, it was required that time corrections be made between recordings, a micrometer adjustment was employed that moved the entire group of recording heads on each deck with respect to each other. A later modification provided a micrometer adjustment on each recording head to correct for geophone position correction.



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LEADING THE FIELD OF SEISMIC EXPLORATION

HERE'S A LOOK AT TODAY'S

Geophysical-Type Magnetic Tape Recorders

. . . a critical and unbiased appraisal of a new tool

by J. D. Skelton

THIS study of commercial magnetic tape recorders shows that each of the seven described should be especially satisfactory for most geophysical purposes. In fact the seismic industry is extremely fortunate to have available so many fine recorders at this early stage in the development of magnetic recording in geophysics.

Magnetic recording . . . The technique of magnetic recording is based on the fact that certain materials when exposed to a magnetic field, retain a degree of permanent magnetization. For magnetic recording, a magnetic substance such as iron oxide is deposited in fine particle form as a thin layer on a strip of plastic film. In the recording process, this magnetic tape is drawn past the recording heads. The signal to be recorded is electrically applied to the coils of the heads and the tape is magnetized in accordance to the signal. To reproduce the recorded signal, the tape is again transported past the heads and an electrical signal is induced in the head coils by the permanent magnetization of the tape. Actually this is an oversimplification of the process, but the intricacies of the magnetic principles involved are beyond the scope of this paper.

Applied to seismic work . . . Magnetic recording is actually a relatively new method for recording data or information in a readily reproducible form. It has been used extensively in the radio, television, and movie industries to record sound tracks. Magnetic recording has also been used in some phases of industry to record test information and performance data. In the past few years the oil industry has started experimenting with the use of magnetic recording in geophysical operations. A seismic record which is recorded in the field with a magnetic tape recorder may be played back later in an office or laboratory where it can be more conveniently and completely analyzed. With the trend toward the solving of more difficult exploration problems, it appears that magnetic recording will find extensive use in seismic operation. As more experience is obtained with this new instrumentation method, magnetic tape recording will most likely prove to be a very valuable tool for the oil industry.

Recently several manufacturing companies have designed and are offering for sale or rent magnetic recording equipment specifically constructed for geophysical applications. It is the purpose of this paper to describe briefly and compare these recorders in the most unbiased manner possible. Since seven different recorders are described, only the salient feature of each will be presented due to space limitations. The various specifications and data presented have been obtained from advertising brochures and personal contacts with the various manufacturers. They are not based on any measurements by the author.

Recording the signal . . . There are two significant ways in which tape recorders differ: (1) the method of recording the signal on the tape and (2) the manner in which the tape is transported past the recording head.

Three methods of recording the signal are ordinarily used:

1. **Frequency modulation** in which the frequency of a constant amplitude carrier is varied according to the signal.
2. **Pulse width modulation** in which the width of uniformly spaced pulses are varied according to the signal.
3. **Bias recording** in which the signal is mixed with a high-frequency bias current and impressed upon the head.

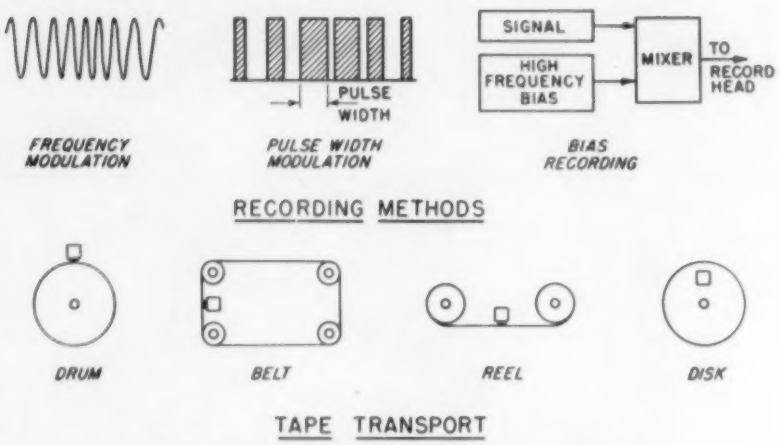

Fig. 1—The various recording and tape transport methods.

These recording methods are illustrated diagrammatically in Fig. 1. Each recording method has its particular advantages and disadvantages. Frequency and pulse width modulation do not depend on the faithful reproduction of amplitude changes in the tape magnetization so that head contact and tape characteristics are not so critical. One advantage that is claimed for pulse width modulation is that tape transport speed variations do not modulate the carrier to cause speed "wow" noise as is the case with FM recording. Bias recording has the advantage of simpler driving circuits; it has been used extensively for many years in the audio industry. A limitation of bias recording is the inability to record faithfully very low-frequency signals of less than 15 cycles per second. Four general methods are used to transport the tape past the recording heads:

1. On a rotating drum.
2. In the form of a disk that is rotated by the heads.
3. In an endless belt around idler rollers.
4. By pulling from a supply reel to a take-up reel. These transport systems

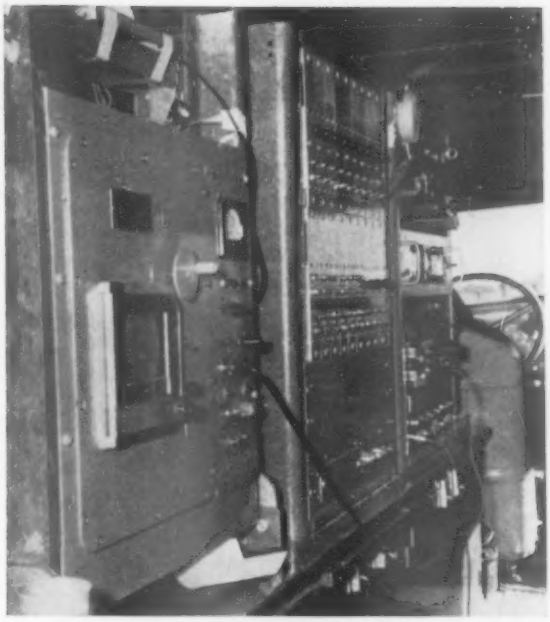

Fig. 2—Ampex uses a 24-channel drum-type recorder with FM type recording.

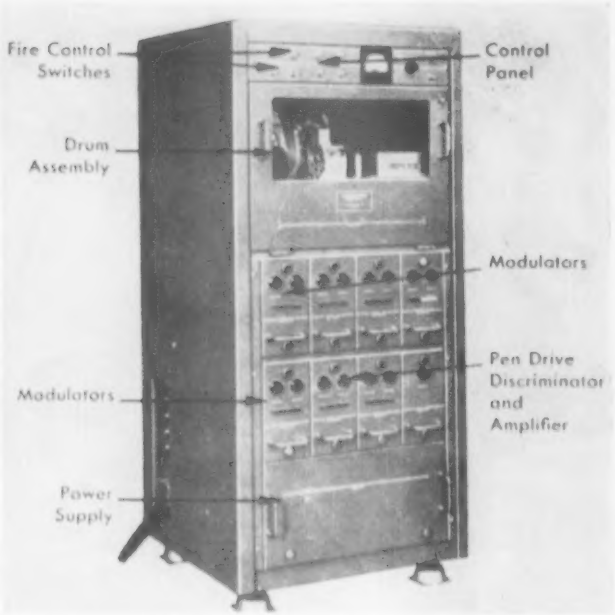

Fig. 3—The Brush Model BK 315 makes the tape record during the shot by using seismic amplifiers to drive the modulators.

Exploration—Skelton

are illustrated in the lower portion of Fig. 1. The drum type provides a convenient and rigid mounting for the tape. Ordinarily a rubber coating is applied to the drum surface to maintain a flexible backing to the tape insuring better head-to-tape contact. With the belt-and-reel type, the tape is pulled over the heads under tension to provide good head contact. The reel-type transport has the advantage of almost unlimited record length.

The disk system has not tape gap around its periphery so that synchronism between the disk rotation and dynamite shooting time is not required.

In the following paragraphs short descriptions of the various commercial tape recorders are presented. They are described in alphabetical order.

...The Ampex Model 700 magnetic tape field recorder is pictured in Fig. 2. It is a 24-signal channel drum-type recorder using FM-type recording. The recorder is designed to be used with conventional seismic equipment. During the shot, the outputs of the seismic amplifiers are fed to 24 FM-type modulators which drive the recording heads to record the tape record. After the shot the same heads are used to play back the recorded signals through 24 FM demodulators. The demodulator outputs are fed to amplifiers which drive a galvanometer-type oscillograph to provide a field monitor record. The recorded tapes are labeled and stored for future playback in the office or in the field. In the figure, the Ampex recorder is shown integrated with conventional seismic equipment in a regular instrument truck.

...The Brush Model BK 315 field recorder is also a 24-signal channel drum-type recorder and uses FM-type recording (Fig. 3). The tape record is made during the shot by using seismic amplifiers to drive the modulators. To produce a field monitor record each channel is played back one at a time through a single demodulator to an electrosensitive pen recorder which reproduces that trace on teledeltos paper which is also wrapped around the drum.

After each trace is reproduced, the pen automatically steps over in position to write the next trace on the teledeltos paper monitor record. Timing traces are reproduced along each edge of the monitor record for timing purposes. The use of the teledeltos-type monitor record eliminates the need for photographic facilities to produce a field record. The drum assembly is mounted on a sliding rack for easy access and the electronic chassis are rack mounted below the drum unit.

...The Electro-Tech Model DS-2 tape recorder is a 12-signal channel reel-type recorder and uses pulse width modulation. The tape transport unit is kept closed except when the supply reel is loaded at the start of a day's shooting. In this manner, dust and dirt are kept from the tape and heads. During the shot, the tape is pulled from a supply reel over the recording heads and wound on the takeup reel. To play back the tape record after the shot, the tape is automatically backed up from the takeup reel to the supply reel until the start of the record is reached. During playback the tape record is again pulled past the heads and wound up on the takeup reel.

At the end of the day's work the entire length of tape for the day's shooting, which is then on the takeup reel, is removed from the recorder for future playback. With this type of continuous tape supply, records of any length can be made. Conventional seismic amplifiers are used to drive the pulse width modulators and a galvanometer-type oscillograph provides the field monitor record. This 12-channel recorder is contained in two lightweight packages and should be ideal for portable use.

...The Magna-Disc recorder of Houston Technical Laboratories is pictured in Fig. 4. This is a disk-type recorder using FM recording. Up to 48 channels may be recorded on each side of an 18-in. disk of Milar plastic having magnetic coatings on each surface.

THE AUTHOR

J. D. Skelton is a geophysical research engineer with Carter Oil Co. in Tulsa research laboratory. He received a B.S. degree in electrical engineering from Kansas State College in 1948. Since that time, he has been associated with Carter in geophysical research work. He has devoted much of his time to the study of various seismic equipment and interpretational problems. In 1954 Skelton received an M.S. degree in electrical engineering from Oklahoma A. & M. College.

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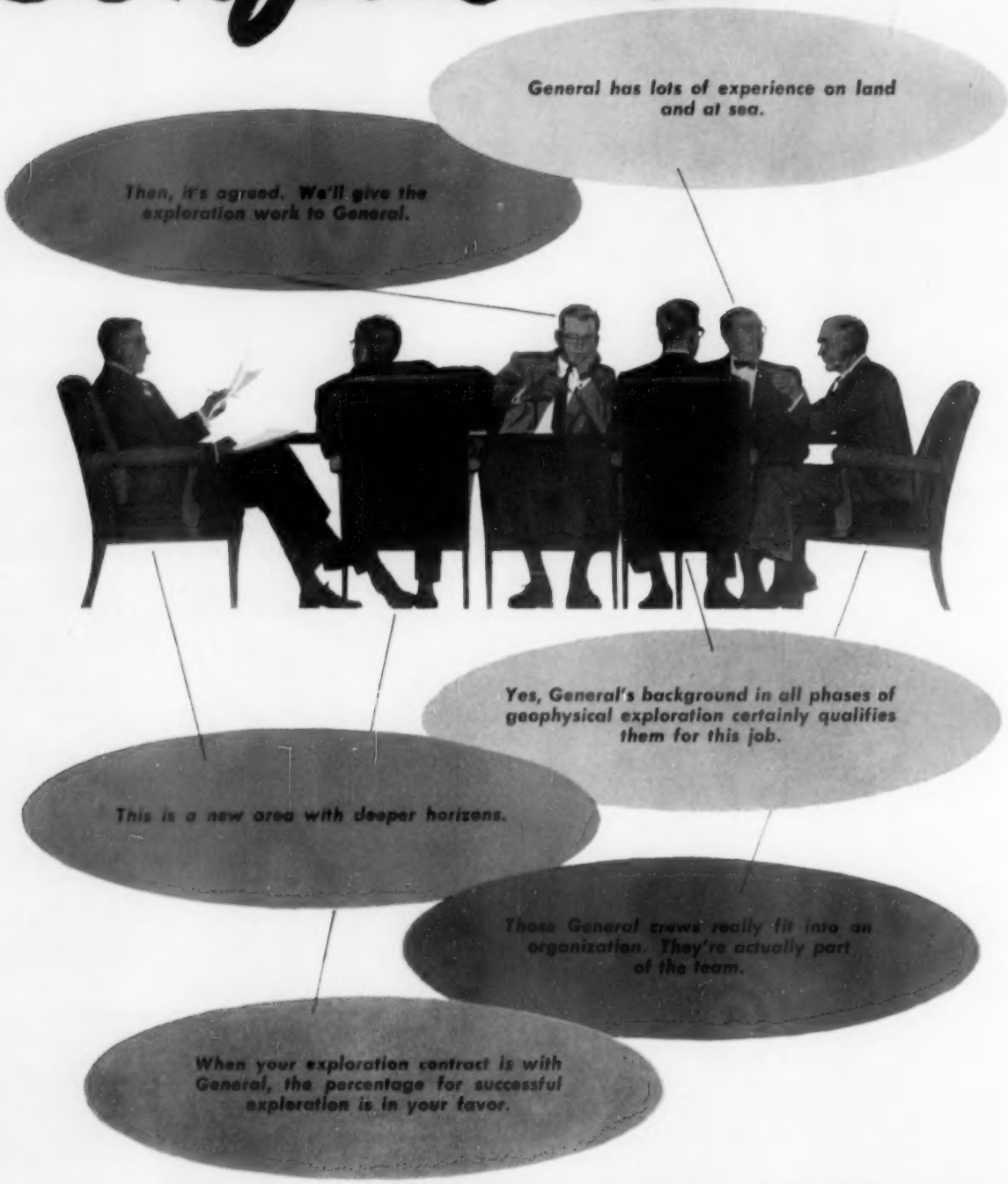
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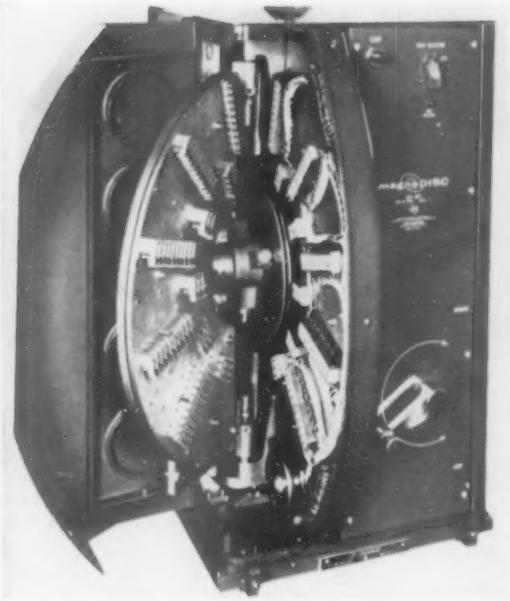

Fig. 4—The Magna-Disc recorder uses FM recording and can record up to 48 channels on each side of an 18-inch disk.

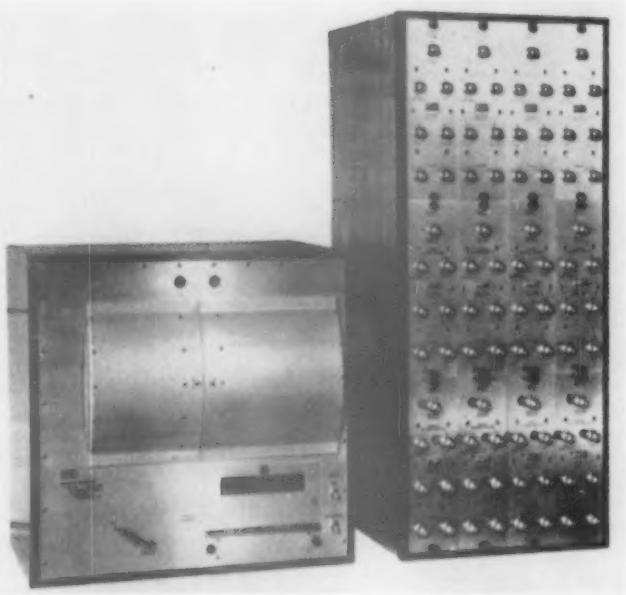

Fig. 6—Southwestern Industrial Electronics Co.'s NR-4 recorder uses FM recording and is designed to be used with conventional amplifiers.

Exploration—Skelton

Recorders can also be supplied which use both sides of the disk simultaneously for 96-channel recording. If 24-trace equipment is used, four separate records are made on each disk. The disk is fastened vertically on a spindle in the recorder and is rotated about recording heads that are mounted on a vertical circular plate. The heads are accurately located so that disks from different recorders can be played back in an interchangeable manner. Gearing is used to couple the motor drive to the disk spindle and an electronic speed wow compensator is used to remove noise that might be generated by the gears since FM recording is used. Conventional amplifiers are used to drive the modulators and an ordinary oscillo-

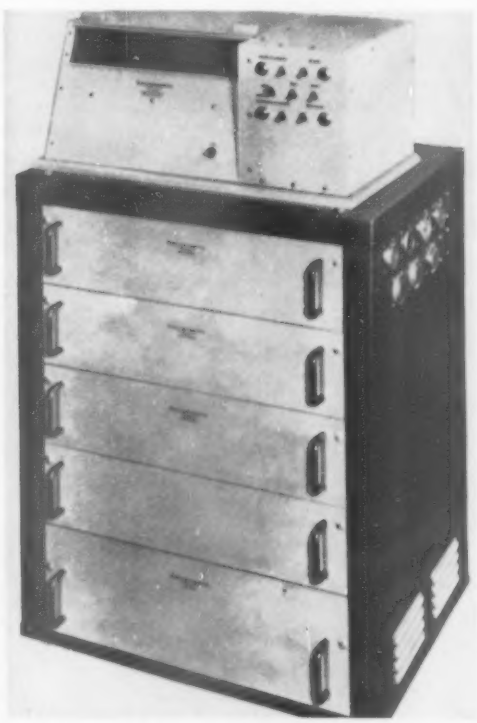

Fig. 5—Techno Instrument Co. manufactures the Mirragraph Model TI-400A. It is a drum-type recorder and uses bias type recording.

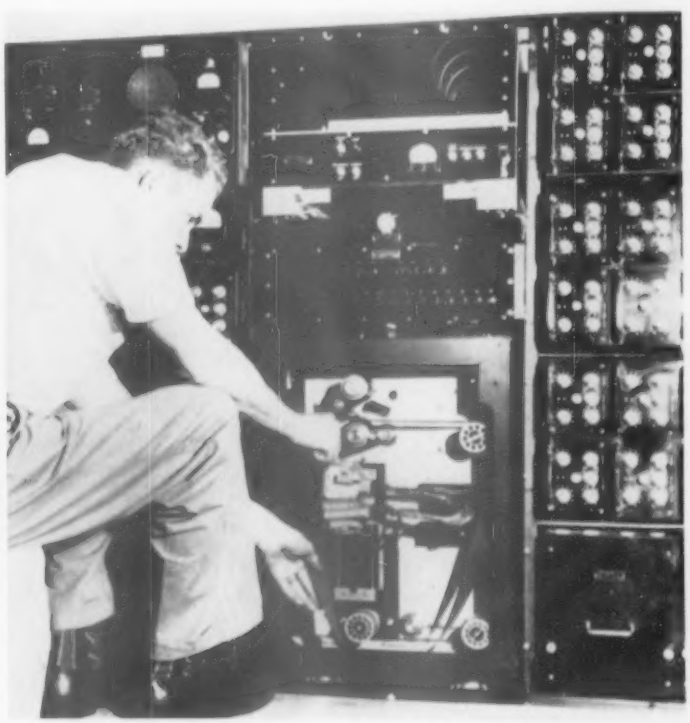

Fig. 7—United Geophysical Co. has a 24-channel belt-type tape recorder that can be used in conjunction with United's conventional seismic equipment.

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graph is used to produce a field monitor record. This equipment is designed to be used either for truck mounting or for portable operations.

. . . The Mirragraph Model TI-400A recorder of Techno Instrument Co. is shown in Fig. 5. It is a drum-type 24 or 48-signal channel recorder which uses bias-type recording. The record is made on Milar magnetic film sheets that are 12 by 24 in. This recorder is designed to be used with conventional seismic amplifiers to provide the head driving signal. The reproduce circuits have low-frequency compensators which provide a frequency response that is flat and phase correct down to 20 cycles per second. A conventional oscillograph is used to produce the field monitor record.

Since bias recording is used, speed wow noise is unimportant and gear coupling is used between the synchronous motor and the drum so that very accurate drum rotational speeds are obtained. A unique feature of the Mirragraph recorder is the provision for adjustments of the recording heads in the time direction. With this provision it is possible to enter static time corrections during playback of the tape sheet.

. . . Southwestern Industrial Electronics Co. NR-4 recorder is a 24-channel recorder which uses FM recording (Fig. 6). This unit is designed to be used with conventional amplifiers to drive the FM modulators and a conventional oscillograph to provide a playback field monitor record. If a permanent field monitor record is not required, a phosphorescent drum can be attached to the tape drum. During playback the phosphorescent drum is exposed for several revolutions to 24 galvanometer light beams that are driven by the demodulators. The phosphorescent record persists for about 2 minutes so that the operator can determine the quality of the tape recording.

A special feature of the recorder is an electronic noise compensator. An unmodulated carrier is recorded on an extra trace during recording. Any speed wow which is present modulates this steady carrier and on playback the noise compensator trace is demodulated to produce a noise signal that is then subtracted from the signal traces. With the noise compensator, a high signal-to-noise ratio of 60 db. can be obtained. If a high degree of accuracy in the drum rotational speed is required, a tone generator can be supplied on the drum.

The tone signal which is produced is made to lock in phase with a standard-frequency signal by a servo system controlling the drive motor. This speed control system holds the drum speed constant within ±½ millisecond throughout the record.

. . . United Geophysical Co. uses a 24-signal channel belt-type recorder with FM recording. This recorder is available only under a contract arrangement along with United's regular seismic equipment and is not for sale as are the other recorders previously mentioned. The tape is spliced into an endless belt and is driven by a capstan drive over idlers in a rectangular path so that the tape is drawn over two recording head banks. Each head bank contains 14 channels with its record tracks being recorded between the tracks of the other head.

Since the same heads are used for playback, the physical displacement of the heads causes no time error. The head banks are designed so that the individual heads in each bank may be displaced in the time direction by the insertion of adjustable "combs." These combs provide static time corrections during playback of ±20 milliseconds. The regular United seismic amplifiers are used to drive the modulators and a field monitor record is produced by the United type oscillograph.

Comparison of recorders . . . A comparison of the specifications and operational characteristics of these seven commercial tape recorders is presented in the accompanying tables.

Table 1 indicates the type of tape transport, tape size, and type of recording used.

Table 2 shows the number of traces, record length, and time accuracy.

All of the recorders provide at least 24 signal traces (Electro-Tech will supply 24 signal channels by using 4-in. tape) which is a fair standard number for seismic instruments. Utility traces may be used for recording shot time, uphole times, punch-level indication, or for any other purpose desired. The record length is 5 seconds or more in all cases which should be sufficient for most geophysical prospecting areas. The trace-to-trace timing accuracy denotes the accuracy of head alignment between different recorders of the same manufacturer. This is important when field tape records are to be played back on office setups. Since seismic time picks are ordinarily made to an accuracy of 1 millisecond, all of the recorders seem satisfactory in this respect.

Table 3 compares the transport speed,

TABLE 1—TYPE OF TAPE TRANSPORT, TAPE SIZE, AND TYPE OF RECORDING

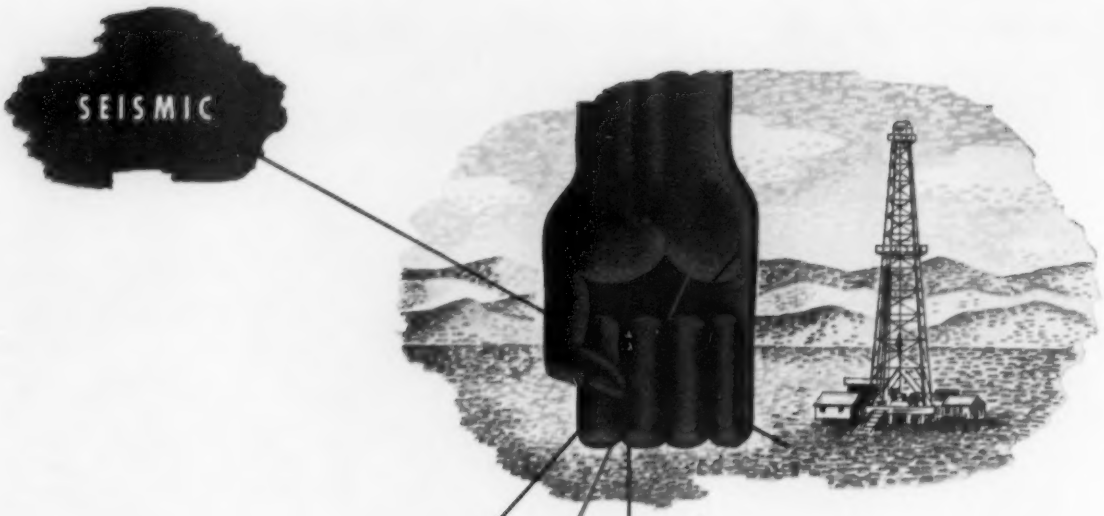
	Tape transport	Tape size	Type of recording
Ampex Model 700	12¾-in. drum	4 by 40¼ in.	FM
Brush BK-315	12-in. drum	2¼ by 42 in.	FM
Electro-Tech DS-2	Continuous reel	2-in. (14 channel) 4-in. (28 channel)	PWM
Magna-Disc Houston Tech Lab.	Disk	18¾ -in. dia.	FM
Mirragraph TI-400A	7½-in. drum	12 by 24 in.	AM (bias)
S.I.E. Model MR-4	14-in. drum	4 by 45½ in.	FM
United Geophysical	Belt	2 by 54 in.	FM

TABLE 2—NUMBER OF TRACES, RECORD LENGTH, AND TIMING ACCURACY

	Signal traces	Utility traces	Record length (seconds)	Trace to trace time accuracy
Ampex Model 700	24	2	5	±1 M.S.
Brush BK-315	24	4	5	±1 M.S.
Electro-Tech DS-2	12	2	Unlimited	±1 M.S.
Magna-Disc Houston Tech Lab.	1-48	5	5	±½ M.S.
Mirragraph TI-400A	1-48	2	6	±1 M.S.
S.I.E. Model MR-4	24	4	5.5	±¼ M.S.
United Geophysical	24	4	5.4 or 7.2	±1 M.S.

TABLE 3—COMPARISON OF TRANSPORT SPEED, MOTOR TYPE, AND MOTOR-TO-TAPE TRANSPORT COUPLING METHOD

	Tape transport speed	Type of motor	Motor coupling to transport
Ampex Model 700	7.5 in per sec.	Synchronous fork control	Belt to friction rim drive
Brush BK-315	7.5 in per sec.	Synchronous fork control	Two-Stage friction rim drive
Electro-Tech DS-2	15 in. per sec.	D.c. governor controlled	Belt to roller drive
Magna-Disc Houston Tech Lab.	12 r.p.m.	D.c. Servo controlled	Gears
Mirragraph TI-400A	3.6 in per sec.	Synchronous fork control	Gears
S.I.E. Model MR-4	7.5 in. per sec.	Synchronous fork control	Two-stage friction rim drives
United Geophysical	7.5 or 10 in. per sec.	Synchronous fork control	Gearing to Capstan drive wheel



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motor type, and the motor-to-tape transport coupling method of the recorders. Seven and one-half inches per second appears to be a common tape speed for the FM-type drum recorders. Electro-Tech, which uses a continuous reel drive, is not restricted by tape length and can use a higher tape speed. Mirragraph has a lower speed because bias recording is used.

All of the recorders except Electro-Tech and Magna-Disc use fork-controlled synchronous motors for accurate motor speeds. Magna-Disc uses a d.c. motor that is speed controlled by an electronic servo system. Electro-Tech uses a simple governor-controlled series motor since pulse width modulation is used and very constant tape transport speed is not required. Magna - Disc, Mirragraph, and United use a gear coupling between the motor and tape transport. Mirragraph is not troubled by gear ripple since bias recording is used. United filters the gear ripple with mechanical filtering (a flywheel and a flexible coupling); and Magna - Disc compensates for gear ripple electronically. The others use various forms of belt and friction rim-drive couplings.

The type of recording heads and the method of loading the leads to the tape is indicated in Table 4. Ampex, Brush, Electro-Tech, and United use multichannel head banks; these consist of individual magnetic recording heads that are clamped or plastic cast together to form the head banks. Magna-Disc, Mirragraph, and S.I.E. use separately mounted heads that are individually spring loaded against the tape. The Ampex head bank is gravity loaded to the tape and the brush head bank is lightly spring loaded. Electro-Tech and United Provide tape-to-head contact by having the tape drawn over the head banks with pressure plates behind the tape.

In Table 5 the various electrical characteristics of the seven recorders are compared. The frequency-modulation systems have carrier frequencies ranging from 2,700 to 4,500 cycles per second and use a maximum carrier deviation of 40 to 75 per cent. Deviations higher than 50 per cent are obtained with special modulator circuits. Electro-Tech uses an 800-cycle per second (crystal controlled) pulse repetition rate and varies the pulse width 80 per cent for maximum modulation. All of the recorders have less than 2½ per cent maximum harmonic distortion which should be satisfactory for geophysical work. The frequency response of these recorders is sufficiently flat throughout the seismic frequency range.

A very important quality of a recording system is its inherent signal-to-noise ratio. This is a very hard quality to compare since the value obtained depends greatly upon the method and conditions of the measurement. Table 6 compares the signal-to-noise characteristics quoted by the manufacturers of the seven commercial recorders. The type of measurement and the frequency pass band of the measurement is also given. A peak-to-peak ratio measurement denotes the ratio between the peak value of the maximum signal to the peak value of the noise. An R.M.S. to R.M.S. ratio is the ratio between the R.M.S. (root mean square) value of the maximum signal and the R.M.S. value of the noise.

Depending upon the wave shape and type of the noise, an R.M.S.-type ratio is usually about 6 db. more favorable than a peak-type ratio made under similar circumstances on the same equipment. The pass band of measurement should be broader than the anticipated frequency range to be recorded. This is the case for most of the measurements quoted. When the type of measurement is considered, all of the recorders seem to have comparable signal-to-noise ratios which average about 50 db. (R.M.S. to R.M.S.). S.I.E. quotes a ratio of 60 db. by using the aforementioned noise compensator and a 1 to 100 cycles per second frequency pass band.

In Table 7, the power drain, total weight, and total volume of the seven recorders described are shown. The values shown are for standard equipment and in some cases smaller and lighter equipment can be supplied especially designed for portable operations. The power drain figures are maximum values for actual recording with standby or warmup drain usually being considerably less.

TABLE 4—TYPE OF RECORDING HEADS AND METHOD OF LOADING

	Recording heads	Head loading	Time corrections
Ampex Model 700	Fixed bank	Bank gravity loaded	None
Brush BK-315	Fixed bank	Bank spring loaded	None
Electro-Tech DS-2	Fixed bank	Tape drawn over heads	None
Magna-Disc Houston Tech Lab.	Separate	Separately spring loaded	None
Mirragraph TI-400A	Separate	Separately spring loaded	±0.090 sec.
S.I.E. Model MR-4	Separate	Separately spring loaded	None
United Geophysical	Two fixed banks	Tape drawn over heads	±0.020 sec.

TABLE 5—ELECTRICAL CHARACTERISTICS

	Carrier frequency	Carrier deviation (per cent)	Maximum distortion (per cent)	Frequency response
Ampex Model 700	2.7 kc.	40	1	3½-300 c.p.s. ±1 db.
Brush BK-315	4.5 kc.	38	1	5-500 c.p.s. ±1 db.
Electro-Tech DS-2	800 c.p.s.	80		5-500 c.p.s. ±3 db.
Magna-Disc Houston Tech Lab.	4.0 kc.	50	¾	10-300 c.p.s. ±3 db.
Mirragraph TI-400A	Bias	Bias	2½	20-500 c.p.s. ±3 db.
S.I.E. Model MR-4	4.0 kc.	75	1	1-300 c.p.s. ±1 db.
United Geophysical	2.7 kc.	75	2	2-350 c.p.s. ±½ db.

TABLE 6—COMPARISON OF SIGNAL-TO-NOISE RATIOS

	Db. ratio	Type ratio	Measurement pass band
Ampex Model 700	45	Peak to peak	1½-300 c.p.s.
Brush BK-315	53	R.M.S. to R.M.S.	5-500 c.p.s.
Electro-Tech DS-2	52	R.M.S. to R.M.S.	Wide band
Magna-Disc Houston Tech Lab.	46	Peak to Peak	5-200 c.p.s.
Mirragraph TI-400A	50	R.M.S. to R.M.S.	20-500 c.p.s.
S.I.E. Model MR-4	50	R.M.S. to R.M.S.	1-500 c.p.s.
United Geophysical	45	Peak to Peak	5-500 c.p.s.

TABLE 7—COMPARISON OF POWER DRAIN, TOTAL WEIGHT AND TOTAL VOLUME

	Power drain (watts)	Total weight (lb.)	Total volume (cu. ft.)
Ampex Model 700	504	242	10.9
Brush BK-315	480	500	13.0
Electro-Tech DS-2	175 (12 traces)	85 (12 traces)	2.8 (12 traces)
Magna-Disc Houston Tech Lab.	210 (24 traces)	282	8.4 (24 traces)
Mirragraph TI-400A	288 (24 traces)	333 (24 traces)	10.2 (24 traces)
S.I.E. Model MR-4	564	440	8.3

Punched cards in geophysics . . .

Fig. 1—Map A is a total gravity map of part of Meade County, Kansas.

Electronic Calculators Speed Up Analysis

by W. O. Heap

GEOPHYSICISTS are now using electronic calculators as a rapid method of analyzing large amounts of complex data. In the past, the geophysicist has often been forced to oversimplify his mathematical analysis because of the time and manpower required to handle these data.

In exploration geophysics, there has always been the problem of having a large volume of data to which certain mathematical reductions must be made as rapidly as possible. This is particularly true in seismic, gravity, and magnetic exploration.

Often it has been the desire to augment the interpretation of these data with a more detailed mathematical analysis. This seldom was attempted due to lack of time. Punched-card computing with electronic calculators can now solve most of these problems.

Tests have shown that the electronic computer can solve some of the problems encountered in geophysical applications 900 to 1,200 times faster for approximately one-tenth the cost of assigning two skilled computers the task.

Some of the common geophysical problems which punched-card processing and calculating machines can help solve are: (1) computing time-depth conversion data; (2) solving variable velocity problems; (3) computations of true depths and displacements of seismic reflection points for steeply dipping areas; (4) computing data for the construction of wave-front diagrams; (5) solving multilayer refraction problems; (6) reduction of gravity data; and (7) integrating continuous velocity logs.

Other problems, such as correlating seismic records and correlating electric logs are being investigated. The taking of the data from the records or logs, however, is laborious; this approach is of interest only in the aspect of future application with automatic curve following equipment or magnetic tape read units.

Electronic calculations . . . The application of punched cards in accounting has long been an established means of rapidly processing a multitude of data. These machines provide companies with complete, accurate, and up-to-date reports. With the advent of electronic calculators since World War II, great progress has been made in the handling of accounting records; but perhaps greater strides in computational studies have been, and will continue to be made in almost every field of engineering and research.

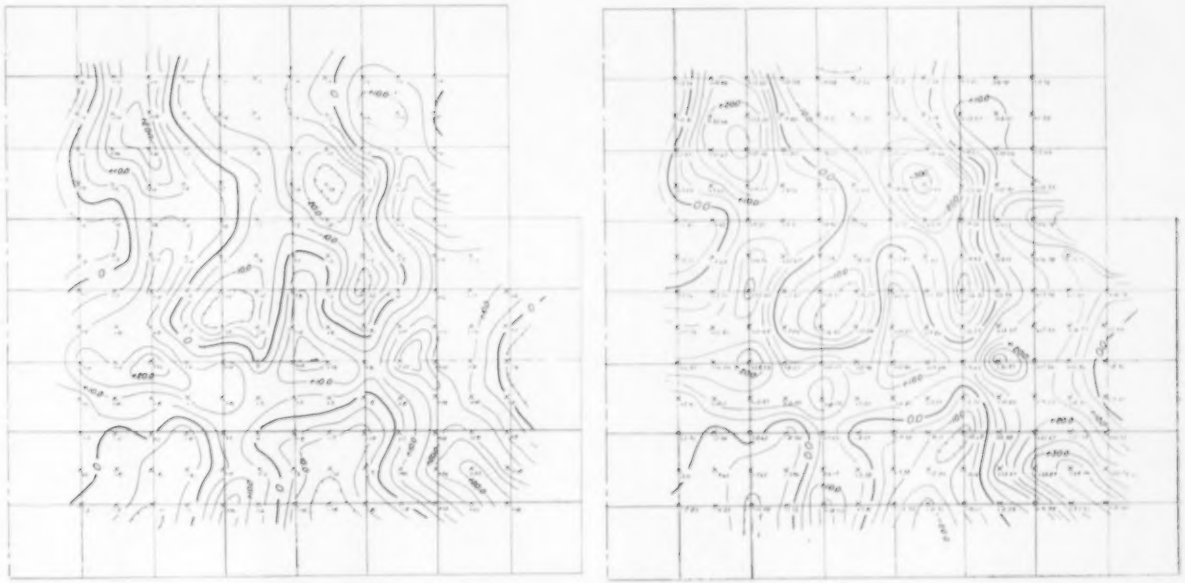
These electronic morons (for in truth, they can do only what they are specifically instructed to do) can turn out a prodigious amount of work in a very short time without complaining of being overworked and without the necessity of taking a "coffee break." These calculators, when so instructed, are capable of performing only the basic fundamental operations listed below:

1. Read a number.
2. Write a number.
3. Change the sign of a number.
4. Change its decimal point.
5. Add two numbers.

Subtraction is, of course, a combination of 3 and 5; multiplication of 4 and 5; division of 3, 4, and 5, etc. It is thus necessary to reduce any expression that is to be solved by the machine into elementary mathematics. This ability to solve difficult problems resides in the fact that the machine can be instructed to perform complicated arrangements of these elementary tasks. There must, then, be a method of controlling and selecting by simple logic the particular order that these fundamental steps are used. This is provided in some manner in all computers of this class.

Reduction of Gravity Data

Several articles have described punched-card applications to the reduction of gravity data and determination of vertical residuals. Automatic means of making such computations is of great value especially in regard to



Maps B and C are residual gravity maps of the same area obtained by two different methods. Notice the similarity between B and C.

# of Complex Geophysical Computations

. . . and enable geophysicists to use more accurate velocity equations

removing the apparent regional effect from the observed field data.

A typical example of machine computations of this sort illustrates a punched-card procedure resulting in two types of residuals obtained at the same time. The field data, after obtaining the Bouguer station values, were put on a map (Fig. 1-A), contoured and a rectangular grid overlay was constructed. At each grid intersection a corrected field value was read and tabulated according to its grid coordinates. These data were punched into cards, verified, and then sorted first in order of the abscissa under the order of the ordinate. The associated field values were then interspersed offset gang punched into the proper cards. The cards were then sorted in order of the ordinate under the order of the abscissa and gang punched as before. With continued re-sorting and gang punching, all associated values were accumulated onto the proper cards. In the case of using the circles or radius S, S√2, and S√5, a total of 16 field values were introduced into each card along with field value of the point for which the residual value was to be determined. The distribution of the field values used in removing the regional gravity effect from the field value at a given point is indicated in Fig. 4 for a typical rectangular grid.

Using Elkins second formula for the second vertical derivative,

$$\frac{\partial g}{\partial z} = 2.419 \times 10^{-5} \left(4.4\,H + 4H'_0 - 3H'\sqrt{2} - 6H'\sqrt{3} \right)$$

This is a special case applicable to the Mead County problem. Normally the constant has value of $1/62k^2r^2$ instead of 2.419×10^{-5} as shown.

the proper weighting of the field values in each circle was accomplished on the electronic calculator and the second derivative of the vertical gravity is obtained. In the same pass of the punched cards through the calculator,

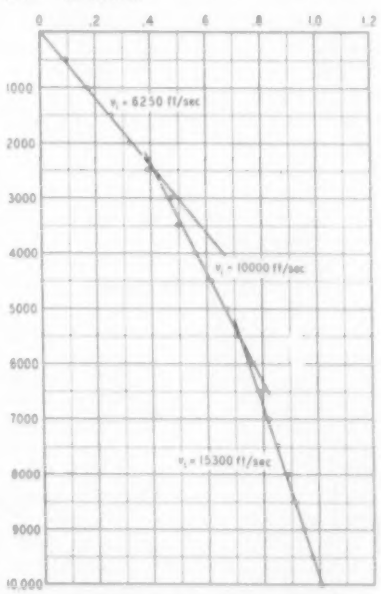


Fig. 2-A—Originally a broken linear velocity function, using three different velocities, was applied to the well-velocity survey.

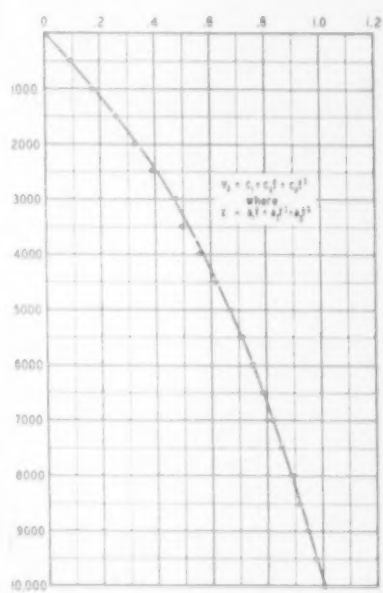


Fig. 2-B—This graph shows that in reality the velocity function is a smooth curve involving a cubic equation.

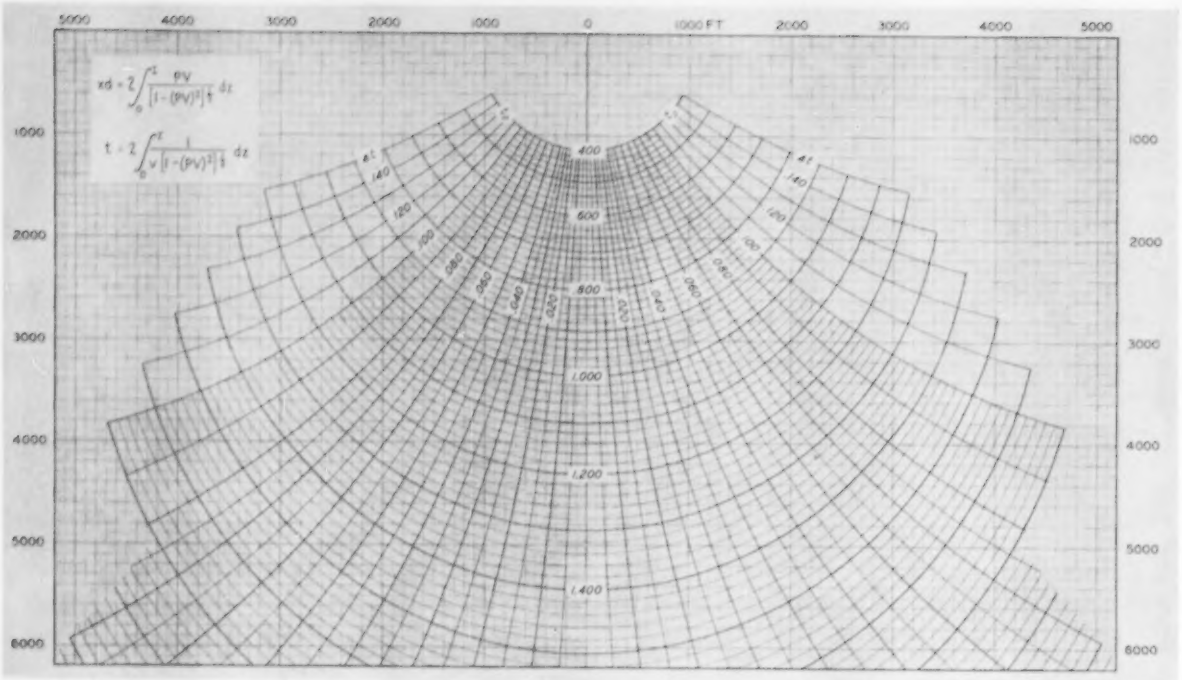


Fig. 3—The steep-dip wave-front diagram is used as an underlay to plot seismic reflections on a cross-section. This diagram is based upon the velocity curve shown in Fig. 2-B.

Exploration—Heap

an eight-point analytical residual is computed using the eight field values on the circle of radius S V 5.

The results of a typical machine application to residual determinations calculated from the data obtained in a gravity survey over a small area in Mead County, Kansas, is illustrated in Figs. 1-B and 1-C.

Variations of these two particular types of residual determinations may be obtained by varying the grid spacing, employing an overlapping grid system, or using some other form of a grid system than rectangular, such as a trigonal grid system. The latter has the advantage of the same number of field values on each circle, giving a more uniform distribution of the field values to be weighted (see Fig. 5).

Variable Velocity Problem

Perhaps one of the most harassing problems facing the geophysicist today is inadequate velocity information. It is often impracticable to analyze thoroughly the data at hand, nor is it possible to investigate properly the velocity distribution in the given area being studied. It is no new problem. But with the emphasis on closer controlled more detailed seismic surveys instead of large reconnaissance programs, the geophysicist must have better velocity control to discover and delineate smaller anomalies.

The recorded seismic data may be accurate to a millisecond, but the true contour of the subsurface reflecting horizon may be completely hidden due to rapid variances in the velocity of propagation of seismic energy. If uphole velocity surveys from several wells in the area of the survey are available, a mathematical analysis of the velocity distribution according to depth and a horizontal plane can be made. This usually leads to a complicated expression for the seismic velocity that is very difficult to use by hand or desk calculator computations.

With the aid of an electronic calculator, the rapid solution of a time-depth conversion at each shot-point location becomes practical. However, we are seldom fortunate in having sufficient velocity control to carry our calculation to such an extreme. Frequently we are able to obtain two or possibly three velocity surveys in or near the immediate area of interest; from these a mathematical average of the vertical velocity as a function of either time or depth can be arrived at which may afford sufficient control. Generally, when such a determination is done by hand computation, the geophysicist makes a contour distribution by using either regional or apparent geological structural considerations; or he constructs a simple form of gradient related to vertical travel time to "tie" the known geologic depths in the area.

Old approach . . . If subsurface data on only one well are available, it has been the common practice to use one of three velocity determinations for each seismic horizon mapped. These are: (1) a constant average velocity for each horizon considered; (2) a broken linear function with depth or time for a determination of average velocity; or (3) a simple assumption that the instantaneous velocity is a function of depth. The geophysicist recognized the velocity problem in the given area but he had to keep the mathematical treatment reasonably simple to permit the handling of large amount of data in the limited time available. There was and is perhaps still further justification in such reasoning; the amount of given data may not be sufficient to warrant a more precise mathematical approach to the

THE AUTHOR

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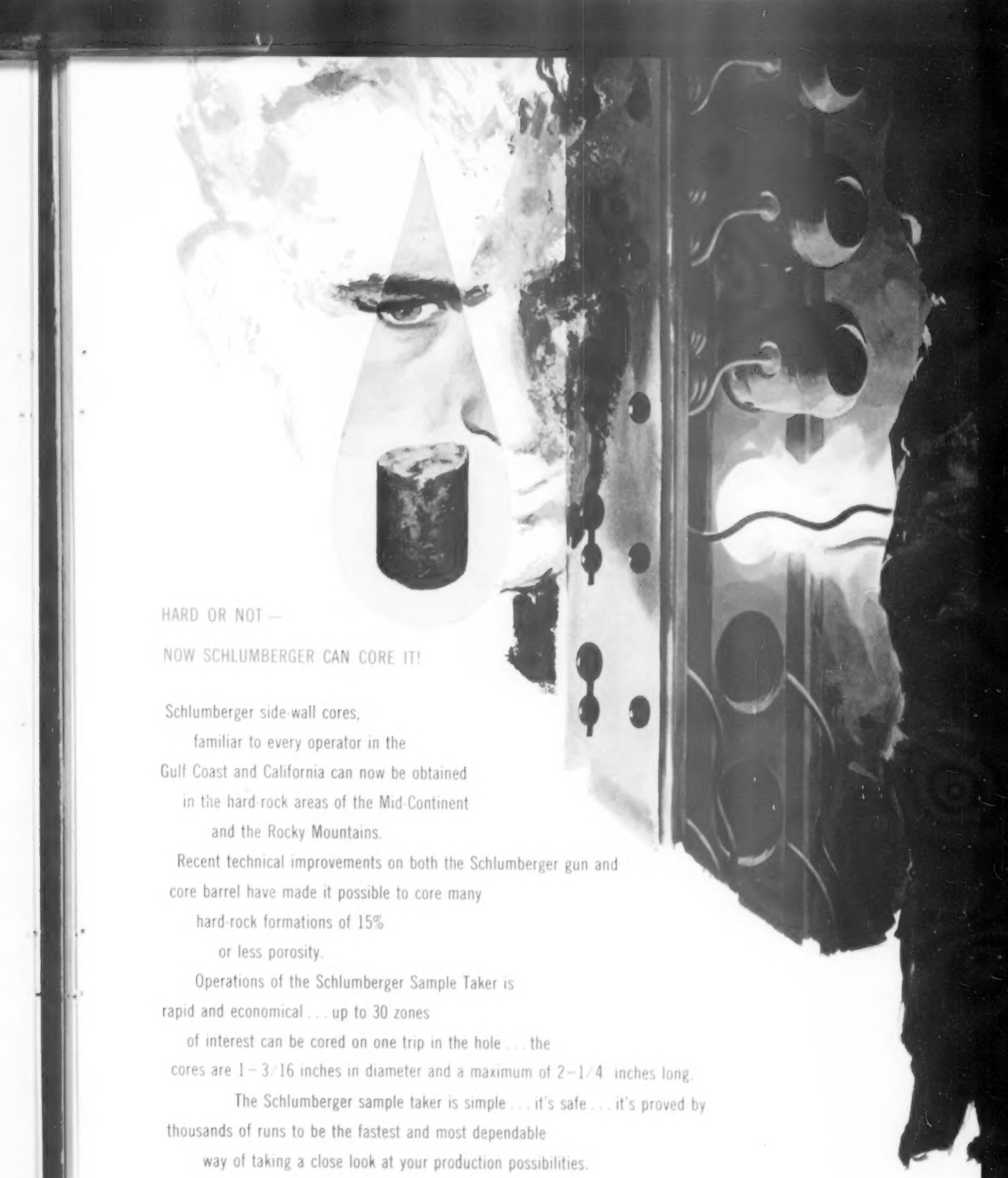

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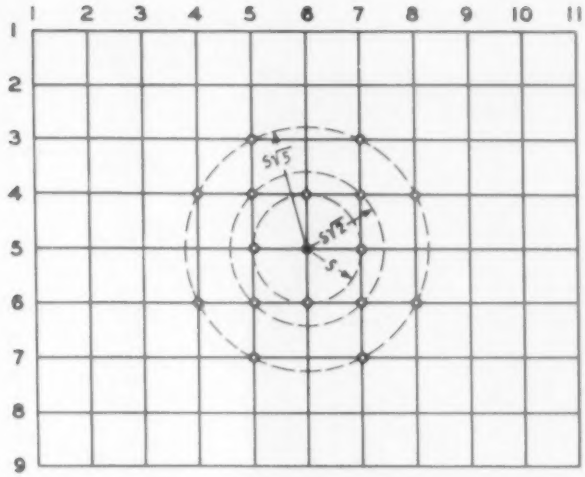

Fig. 4—The eight-point residual gravity map (Fig. 1-B) was computed with the electronic calculator, using the rectangular grid shown. Weighting circles or radii S, S√2, and S√5 were used.

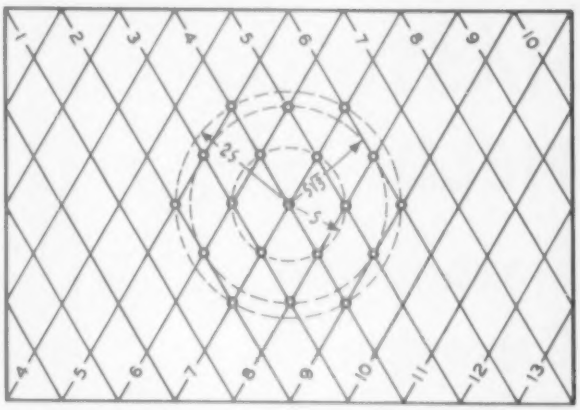

Fig. 5—The trigonal grid system can be used to calculate residual gravity maps. Weighting circles of radii S, S√3, and 2S are usually employed.

distribution of the velocity. The possibility, then of placing too much trust in a laborious treatise of the distribution of the velocity in an area must never be overlooked. Recognition of the amount and validity of the given control must be considered at all times.

However, there have been numerous instances when it has been found that full use of the given data has been overlooked in an attempt to oversimplify the expression to be used. It is in these cases that mechanized calculating methods and equipment are invaluable.

New approach . . . In a particular case, a seismic program was in progress where it was known the subsurface formations varied in dip from 0° to 80° or more; it was necessary to compute the corrected depth and displacement of each depth point. A velocity survey from a well close to the prospect was available which clearly showed that the velocity was not a linear function of depth or time (Figs. 2-A and 2-B). Since the dips of the reflecting beds varied greatly, a simple broken-line velocity relationship was considered impractical (Fig. 2A). This approach would introduce large errors in the calculation of the true depth and displacement of the depth points.

To obtain the velocity of propagation V_Z for any given depth Z as a function F_Z, a practical solution was found to be sufficiently accurate and was employed. A curve was fitted to the given velocity data (Fig. 2-B) using the first four terms of the infinite series

$$y = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + \ldots + a_{n-1} x^{n-1} \quad \ldots (1)$$

The equation arrived at was differentiated to obtain the instantaneous velocity for any given travel time within the limits defined by the given data and a time-depth table was calculated for each millisecond of two-way travel time.

It was decided to use a steep-dip wave-front diagram (Fig. 3) as an underlay on a one-to-one scale cross-section; from this underlay the true dip, displacement, and depth of a reflected event are plotted, using the corrected reflection time and the Δ_t component of travel time which is a function of the emergence angle.

To compute the steep-dip wave-front diagram it was necessary to perform the integration of the generalized formulas for the propagation of a wave front in the stratified portion of the earth's crust. The punched-card electronic calculator equipment was used to perform this integration. It was deemed advisable to program the calculator to check the results of the computations performed and to test whether solutions of the numerical integration were real or unreal, and when unreal to skip out and begin another integration. This programing eliminated the necessity of a large amount of hand computation which would otherwise be necessary to check the accuracy of integration and the limits to which the integrations were valid.

A tabulation of the corrected depth and displacement of the recorded reflection travel times was calculated over a range of 0 to 3 seconds of two-way travel time and a Δ_t time component of dip from 0 to 180 milliseconds. From this tabulation the underlay as mentioned before was constructed (see Fig. 3).

The computations involved over 100,000 calculations and 34,530 punched cards. It was estimated that two men using desk calculators would have to work a minimum of 170 hours a month for 2½ years to compute the same data that the electronic calculator did in a few hours.

This example suggests the possibilities of a thorough investigation of any velocity problem that might be encountered. For instance, if a seismic program is to be conducted in a rank wildcat area where no velocity information is available, it may be desirable to compute average velocities from step-outs. To be of value, this entails a great many determinations from which corrected values may be obtained by least squaring the observed values. This could be performed rapidly by processing the data with punched-card equipment.

Many applications . . . There are an almost unlimited number of geophysical applications to punched-card computing; only a very few have been discussed in this article. Various other problems have been solved, both of the data-reduction type and the data-handling type. Problems dealing in statistical analysis are particularly interesting since they may be classified as both data-reduction and data-handling problems. Correlation of associated recordings such as the seismograms obtained in a seismic survey is of paramount interest for possible immediate and definitely future applications. Machine calculating of average velocities from continuous velocity logs affords a precise mathematical integration of the interval velocity log; this method permits a correction for hole size as obtained from a caliper survey and application of the instrumental delay time.

Geophysicists can apply the punched-card equipment to many daily problems that exist in seismic exploration, research, gravity, continuous velocity logging, and radio-location operations.

GEOPHYSICAL CASE HISTORY

HASTINGS FIELD

Brazoria and Galveston Counties, Texas

by R. A. Weingartner

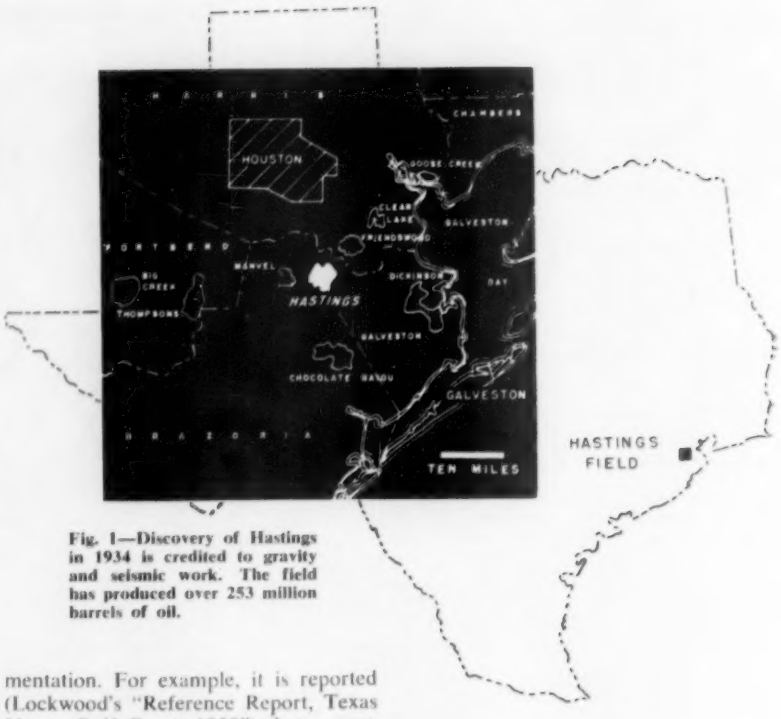

Fig. 1—Discovery of Hastings in 1934 is credited to gravity and seismic work. The field has produced over 253 million barrels of oil.

HASTINGS field, 25 miles southeast of Houston, was located on a gravity anomaly that was checked with reflection shooting.

To understand properly the gravity and seismic pictures, a background of gravity and seismic instrumental development as of 1933 is necessary.

The torsion balance was in widespread use and had proved its worth, particularly in the finding of piercement-type domes (Allen, Ariola, Hankamar, Long Point, Orchard, etc.). It was shortly to be replaced by the gravity meter. As accurate in gravitational measurements, the gravity meter is faster (cheaper), and less sensitive to error incurred by rough terrain.

Reflection seismograph had just replaced refraction seismograph. The reflection method was faster and more definitive. The method, however, was far from its present state of development. Many of the present techniques used to secure optimum reflection-response were yet to be developed. It was common practice to use a total of six detectors, one per trace; today six or more detectors per trace is common practice.

At that time, the detectors were placed 2,000 to 3,000 ft. from the shot point. This was necessary to prevent the noise created at the surface by the shot (low velocity) from reaching the detectors before the reflected energy from the subsurface (high velocity) had time to reach the detectors and be recorded. The instrumentation was crude by today's standard but effective for the objective of that time; namely, to find very large structures.

Few fully understood seismic instrumentation. For example, it is reported (Lockwood's "Reference Report, Texas Upper Gulf Coast, 1939") that a crew set up on what later proved to be the north flank of the Hastings structure for the purpose of testing new recording equipment. It was decided that the instruments were not operating correctly because the records indicated north (reverse) dip when south (normal) dip was expected. This was 6 months before Stanolind shot the area. Similarly, good indications of faulting based on seismic data were simply ignored. It seemed unlikely that such soft beds would break by faulting instead of bending. The geophysicist was not yet sufficiently confident of his data to insist that it was correct nor the geologist yet convinced that extensive faulting of the Gulf Coast sediments was probable. Electrical logging, introduced in the Gulf Coast in 1934, provided convincing evidence of widespread faulting, both local and regional in nature.

Location . . . Hastings oil field lies on the Brazoria-Galveston county line. Its location some 30 miles from the Gulf of Mexico in Texas, and with relationship to other major fields and cities, is shown in Fig. 1.

The surface is typical of the Texas Gulf Coastal Plain. Gentle slopes prevail with drainage toward the Gulf of Mexico. The topographic map, Fig. 2, illustrates the relative flatness of the area. The contours are based on derrick-floor elevations corrected to ground level. The topography appears to rise gently to the west across Manvel field. The topographic contours show no elevation that might be attributed to surface expression of structure. The topographic slope, locally, is eastward into south trending drainage The regional slope is coastward and about 2 ft. per mile. The average surface elevation is 42 ft. above sea level.

The surface sediments are of Beaumont age, Houston group, of the Pleistocene. In general, the sediments form a black soil, gummy and slick when wet. Field-development operations required the construction of graded and shell-topped roads to facilitate transportation. A concrete highway in process of construction had been completed to the prospect and was most useful in the early development period.

The average annual rainfall of 45 in. and average morning humidity of 86 per cent combine at this latitude to make a semitropical climate. Cotton and rice are grown extensively, fig orchards are common, and cattle dot the grass lands.

Gravity Map

The Hastings anomaly was found by a Stanolind torsion-balance crew under the direction of J. C. Jackson in September 1933. Robert H. Ray, geophysicist for Stanolind at that time, interpreted the data. The regional gravity map of the area is illustrated by Fig. 3. This regional picture is based on poorly controlled data but is sufficient to illustrate the position of the Hast-

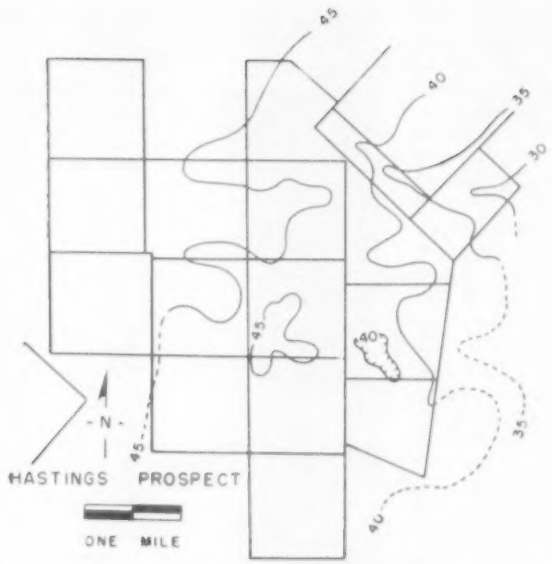

Fig. 2—The topographic map shows that the Hastings area is relatively flat and has average elevation of 42 ft. above sea level.

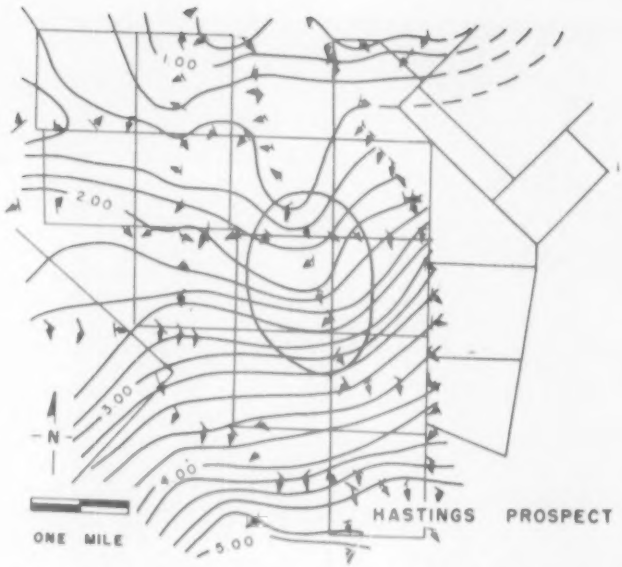

Fig. 4—A detailed total gravity map of the Hastings anomaly shows a strong "nose." Survey is based upon torsion balance work by Stanolind.

ings anomaly with reference to other anomalies on the regional picture.

Regional gravity . . . As a background for the uninitiated, it should be noted that in the Gulf Coast region it is assumed that large regional minima are due, generally, to deep salt masses. The regional gravity strike may or may not be parallel to the regional subsurface strike, particularly as shown by shallower sediments. In this picture, then, any pullout or nosing away from this central low (minimum) area may be considered the effect of uplifts of relatively shallower, locally intruded salt. A dashed circle has been drawn in proximity of the —2.00 milligal closing contour. This dashed circle may be considered an idealized contour of the regional anomaly produced by the deep salt mass.

With this as a background, the Mykawa salt uplift is represented by the pullout to the northwest from this circle, South Houston by the flat pullout to the north, and Manvel by the pullout to the southwest. It will be noted, however, that there is no pronounced pullout or nosing away from this regional low area in the case of the Hastings anomaly. This importance of the anomaly is not apparent as its magnitude has been obscured by the sharpness of the regional gravity gradient or dip.

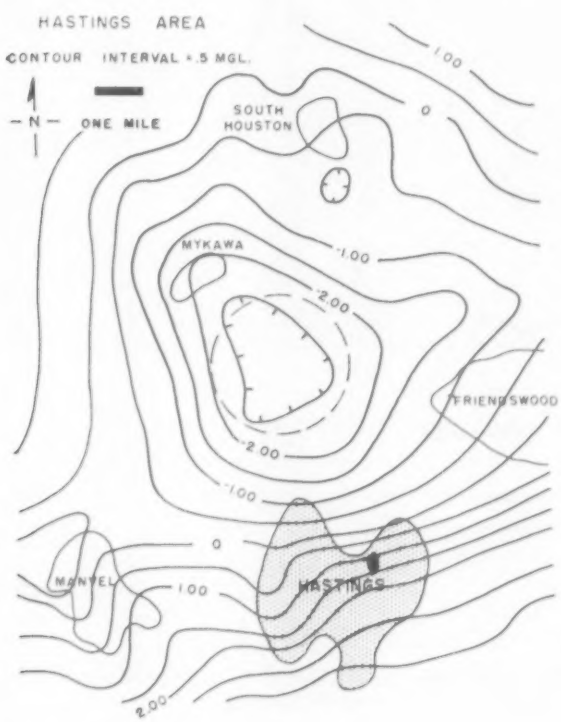

Fig. 3—The regional gravity map shows the relation of the Hastings anomaly with respect to the other anomalies of the area. The large minimum in the center of the map nearly obscures the Hastings feature.

Hastings anomaly . . . On this casual study of the regional gravity picture, Hastings appears considerably less important than Manvel, and on this basis, would not have been recommended for seismic investigation. At that time, only the more important, or "Grade One," anomalies were considered worthy of seismic check.

Fig. 4 shows the Hastings gravity anomaly as it appears in detail. In order to secure a better evaluation of the anomaly as a prospect, a residual (regionally corrected) gravity map was made. The construction of such a map is explained by the following diagrams.

Fig. 5-A is an assumed anomalous gravity picture. The observed or total gravity contours (solid) are shown overlain by dashed lines representing the regional gravity strike. These strike lines form a tilted plane or monoclinal surface and are the interpreter's idea of the regional gravity picture before it was disturbed by local uplift.

Differences between contour values of the observed (total) gravity and the interpreted regional gravity where these two sets of contours (solid and dashed lines) intersect provide the residual (regionally corrected) data. In this example, due to the effect of local salt uplift, the observed gravity data are less than the interpreted regional values. This results in minus data, so that the anomaly shown on the residual (regionally corrected) map, Fig. 5-B, contoured on these data, is a minimum.

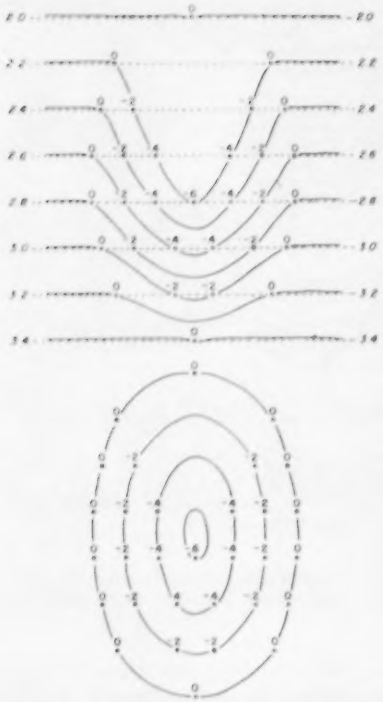

Fig. 5-A—(Top). An assumed gravity anomaly is shown. Total gravity contours are solid; dash lines represent the regional gravity picture.

Fig. 5-B—(Immediately above). The residual map is obtained by subtracting the total gravity at each station from the regional value. Notice that the noxing has become a significant minimum.

Although a simplification, this is basically the procedure used in making the regionally corrected (residual) gravity map of the Hastings anomaly, Fig. 6. This approach, involving the interpreter's idea of the regional effect and its removal, brought out in clear relief the magnitude of the anomaly. By removal of the sharp south gradient, which successfully blanketed the anomaly, a gravity prospect of importance comparable to Manvel on the west was produced. This particular approach was largely responsible for establishing Hastings as a gravity prospect distinctly separated from the Manvel anomaly on the west and of sufficent importance to warrant seismic investigation.

In October 1933 the gravity maps previously discussed were made the basis for a written report. It was at this time that the Hastings minimum was recommended for a check by reflection seismograph. This work, however, was deferred. Instead, early in December of that same year, an area was outlined on the basis of this incomplete torsion-balance picture and acreage was purchased as previously mentioned. Approximately 1,100 acres, or what later proved to be 18 per cent of the producing area, was secured on the basis of this torsion-balance picture.

In March 1934, after this acreage purchase and before the recommendation for seismic investigation was followed, additional gravity control was obtained on the east side of the anomaly. Fig. 4 shows that the gravity survey was not carried a sufficient distance to the east for the adequate control of the outer limits of the anomaly. This early, incompletely controlled gravity picture outlined an area later proved to constitute the western and high part of the structure. The supplemental control secured on the east side

Exploration—Weingartner

THE AUTHOR

Russell A. Weingartner is geophysical coordinator, Stanolind Oil & Gas Co.; a native Nebraskan, he has spent most of his professional life in Texas and Oklahoma. He was educated at University of Nebraska, graduating in 1929 with a B.Sc. degree in geology and chemistry. He then joined Dixie Oil Co. as a geological scout at Wichita, Kans., and in 1930 moved to San Antonio. With the purchase of Dixie by Stanolind in 1931, Weingartner went over to Stanolind as scout and geologist at Tyler and at Houston. From 1936 to 1946, Weingartner served as district geologist and division geophysical coordinator in Houston. Transferred to Tulsa as staff geologist in the geophysical section, he returned to Houston in 1949 as division geologist. This paper will appear in "Geophysical Case Histories, Vol. 2," published by S.E.G.

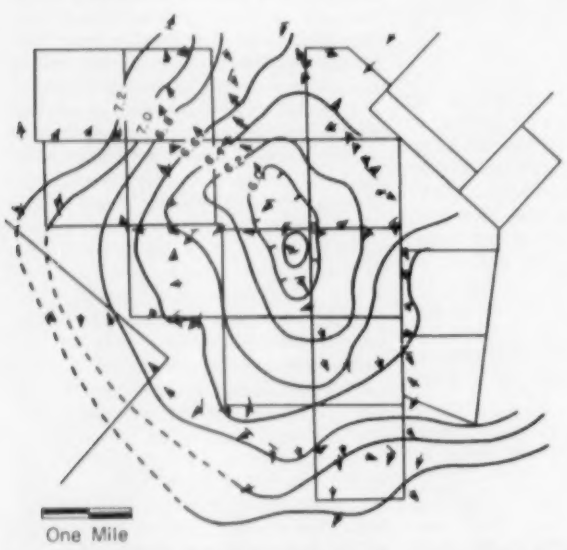

Fig. 6—The residual gravity map of Hastings shows an anomaly of appreciable magnitude. A buying area was outlined using this interpretation.

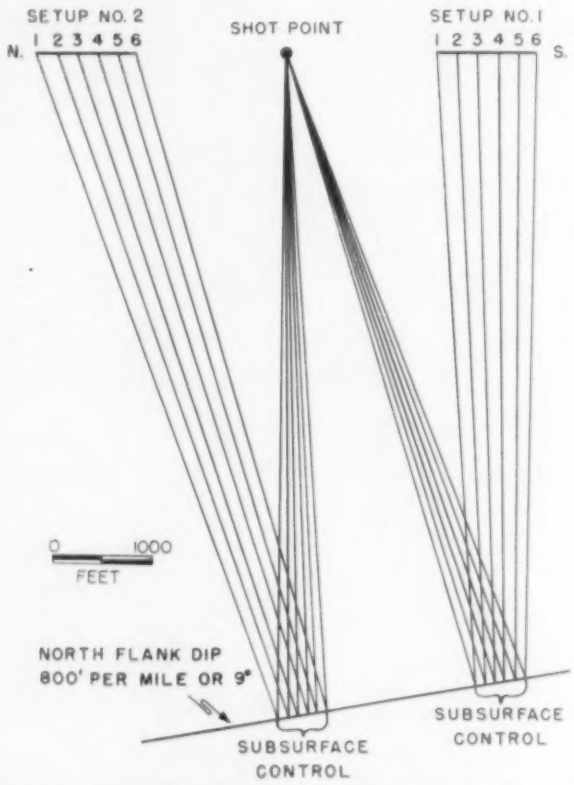

Fig. 7—Early reflection work in 1934 used this type of profiling that resulted in 20 per cent subsurface coverage.

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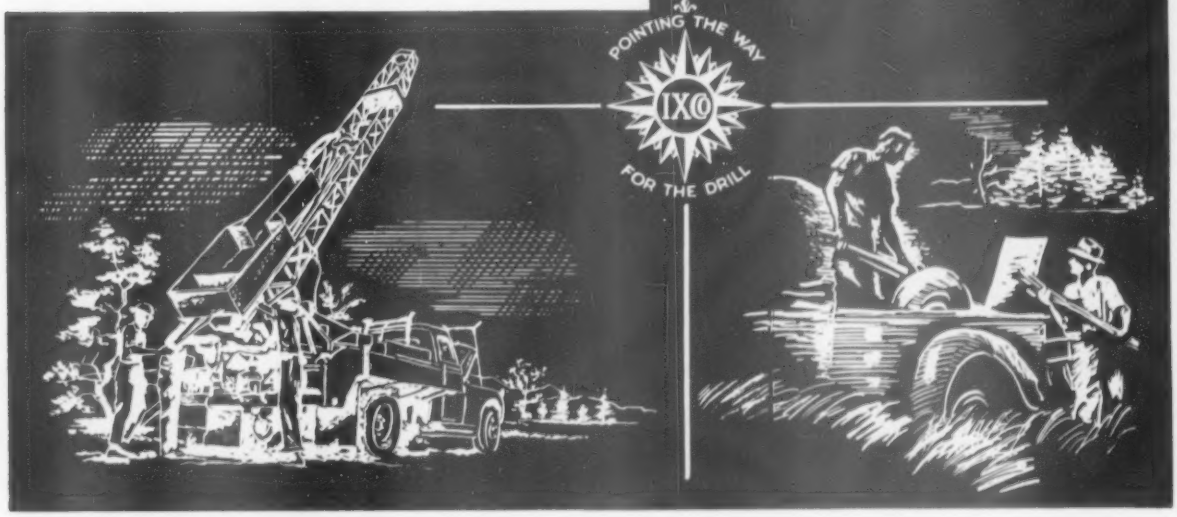

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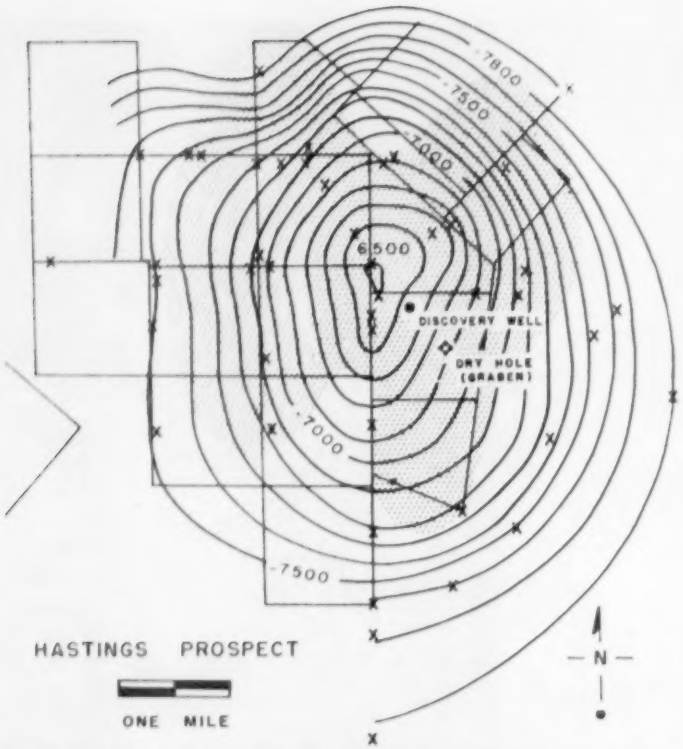

Fig. 8—The seismic picture conforms reasonably well with the present outlines of production (shaded area). The survey failed to map the fault patterns that resulted in the dry hole shown, only ½ mile from the discovery.

of the anomaly provided a complete gravity picture of the area. This picture was found to be in reasonable agreement with the seismic structure as later developed.

Seismic Map

In January 1934, Hastings was recommended for seismic investigation. It was estimated that the work could be done in something over a week's time at a cost of roughly $2,000. It is interesting to note that the cost of seismic work has roughly quadrupled since that time, and returns in terms of oil reserves are many times less. It was noted previously that a crew testing new seismic instruments worked for a very limited time in the north flank of the Hastings structure. Beyond this, there is no record of reflection seismic work in the area prior to Stanolind's entry. Little interest had been manifested by the oil companies, generally, in that particular locality. Comments following the seismic work and block assemblage, but prior to the drilling of the discovery test, were generally unfavorable. At that stage in our geologic thinking, it seemed unlikely that two domes could be so closely spaced. The western limit of production at Hastings is within 2½ miles of easternmost production at Manvel.

About April 14, 1934, an Independent Exploration Co. crew, under the supervision of J. W. Flude and under contract to Stanolind, was directed into the area. Independent Exploration at that time employed a 1,000-ft., six-trace spread using one seismometer per trace. The shot point, located in line with the spread, was some 2,200 to 3,000 ft. from the center of the spread. It was customary to shoot the spread, move it a similar distance on the other side of and in line with the shot point, and shoot the same hole again. In this manner, 1,000 ft. per mile, or roughly 20 per cent, subsurface coverage was secured. This field practice is illustrated by Fig. 7. Setup 1 shows the position of the surface spread (detectors) to the shot point. The hole was shot, obtaining the subsurface control shown. The spread was then moved to the other side of the shot point for setup 2, and the hole was shot again.

The first day's seismic work found 500 ft. of anomalous west dip. The program was interrupted for a few days, following which the crew returned and shot a south-to-north line crossing the south flank, crest, and northwest flank of the structure. On this line, 400 ft. of northwest dip was developed then a northeast line was shot, showing 700 ft. of dip in that direction. The purchase of additional acreage began immediately following the receipt of this information. Until that time no interference from outside companies had been encountered. Reflection seismograph crews from two companies were working in the Friendswood area, to the northeast of Hastings. One of these crews had partially worked an area north of Hastings and this crew returned to complete that program. The permit man for the crew encountered lease brokers assembling the Stanolind block at Hastings and a seismograph crew, under contract to Stanolind, shooting the area. Competition for the purchase of acreage began in earnest. Meanwhile, the Independent Exploration crew continued to shoot the area and completed its work in slightly over a week's time. The completed map, shown by Fig. 8, was based on a total of 47 shot points. As might be expected, there was no indication of the extensive and rather complicated fault pattern which was encountered on development.

The present outline of production, the location of the discovery well, and a nearby dry hole drilled in the early development of the field are shown on Fig. 8. The discovery test, Stanolind 1 J. W. Surface, was located near the crest of the structure. The dry hole, Stanolind 4 Sneed, was abandoned at a total depth of 8,792 ft. in Vicksburg, having encountered water in the top of the Frio sand at 6,186 ft. This dry hole was drilled rather early in the development of the field, and it is interesting to speculate on what might have happened had lease requirements made it expedient to locate this first test at this location only slightly below the indicated crest of the structure. Stanolind 4 Sneed is just ½ mile from the discovery and is located structurally, in a downthrow fault block or graben area.

Production Data

The discovery well was spudded on October 28, 1934, and completed on December 22, 1934. This completion, at a total depth of 5,990 ft., made 153 bbl. of oil in 24 hours on a 3/16-in. tubing choke. The tubing pressure was 2,150 psi., and the gas-oil ratio was high. For this reason, the well was deepened to 6,154 ft. and finally recompleted at a plugged-back total depth of 6,118 ft. on May 1, 1935. The initial production was at the rate of 320 bbl. in 24 hours on a 3/16-in. tubing choke.

The oil is 31° gravity and is pipelined to Pan American Refining Co.

There are 643 wells in an area of 5,600 producing acres. The accumulative production to January 1, 1955, was about 253,500,000 bbl.; the allowable as of March 1, 1955, was 60,586 bbl.

GEOPHYSICAL CASE HISTORY

VEALMOOR FIELD

. . . Borden and Howard Counties, Texas

by Holland C. McCarver

Fig. 1—Careful geophysical work can map reef fields such as Vealmoor.

VEALMOOR field was the first reef field in the horseshoe-shaped Pennsylvanian reef archipelago of the Midland basin (Fig. 1).

Pennsylvanian reef masses, particularly of the Vealmoor field biotherm type, can be successfully mapped with the seismograph. Almost no reflections are obtained from the reef itself, but the presence of such a feature can be recognized from mappable structural draping in the Permian section. Detailed seismic work and joint geological-geophysical program planning in probable "reef country" are essential to the success of such a survey.

Early history . . . The exploration history of Vealmoor field began in late 1943. At that time, Brown & Karcher had a Geophysical Service, Inc., crew make a seismograph survey of the Vealmoor area. This survey revealed a structure with almost 100 ft. of Yates closure, the Yates being the best mappable horizon. A map in the lower Permian, Fig. 2, also showed structural closure but the reflection data were not so reliable as the Yates. No mappable data were obtained below this Permian marker.

The seismic structure mapped was tested to a depth of 6,700 ft. by Brown & Karcher's 1-B Caldwell. The well, shown in Fig. 2, was dry and abandoned at this depth.

About the time Brown & Karcher were testing the Vealmoor anomaly, Seaboard Oil Co. was exploring the Spraberry area in southeastern Dawson County, 15 miles to the northwest. Shallow oil production was established and in 1947 a well was drilled to the Ellenburger to test the deeper producing possibilities of the area. The test was eventually abandoned, but the drill did reveal the presence of an abnormally thick section of Pennsylvanian limestone, some of which was thought to be of "reef" origin. The highly porous nature of the limestone, together with shows of oil encountered, brought about the speculation that under favorable conditions, it might carry oil in considerable quantities.

This possibility was considered when in 1947 Seaboard obtained one-half interest in the nearby Vealmoor block in return for deepening the 6,700-ft. Brown & Karcher test to the Ellenburger.

Discovery and development . . . The Seaboard-Comanche (Brown & Karcher) 1-B Caldwell was completed in Jan-

Fig. 2—This early reflection seismograph map of the Vealmoor area is contoured on a lower Permian marker. Productive areas are shaded.

Fig. 3—Seismograph map of the Vealmoor area at the Spraberry level reflects the underlying reef. Discovery-well location is shown.

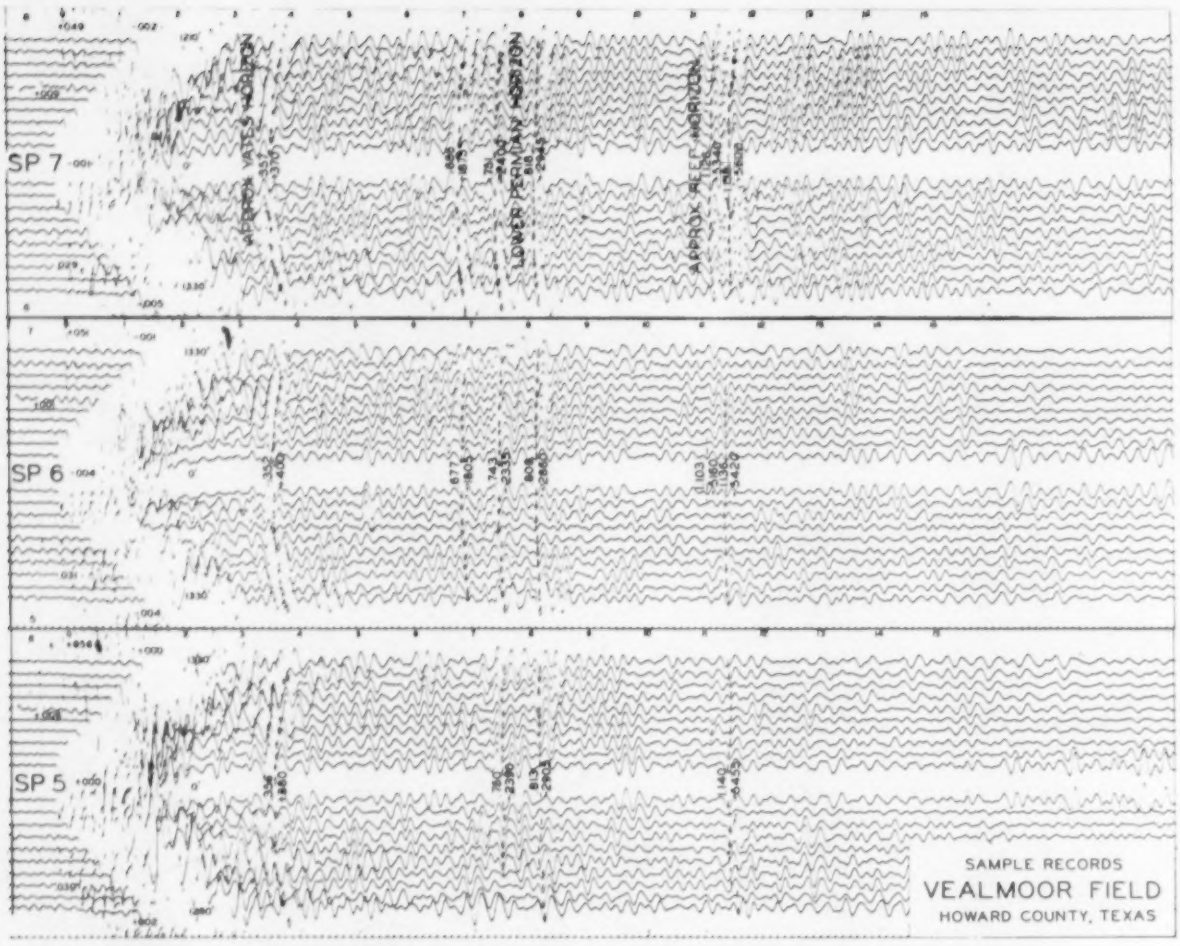

Fig. 4—Sample seismograms from the Vealmoor area. The Yates, Spraberry, and Reef reflections are identified.

Exploration—McCarver

uary 1948 at a depth of 7,974 ft., 1,274 ft. below the total depth of the original well. Initial production was 200 bbl. of oil and 40 bbl. of water per day through a 12/64-in. choke. The "reef" pay was topped at 7,934 ft., with 31 ft. of porous limestone pay above water. As shown in Fig. 2, the 1-B Caldwell was located on the extreme western edge of the Vealmoor productive area.

In an effort to locate a possible structural position higher than this first producer, Seaboard contracted Seismic Engineering Co. to conduct a detailed seismic survey in the vicinity of the discovery well. This survey, the results of which are shown in Fig. 3, indicated that a diagonal offset location to the northeast might prove to be higher. Somewhat to the surprise of the operators, this second test encountered the reef limestone 186 ft. higher than the first well, and flowed 1,162 bbl. of oil per day on a ¾-in. choke.

Seismic results . . . The Seaboard seis-

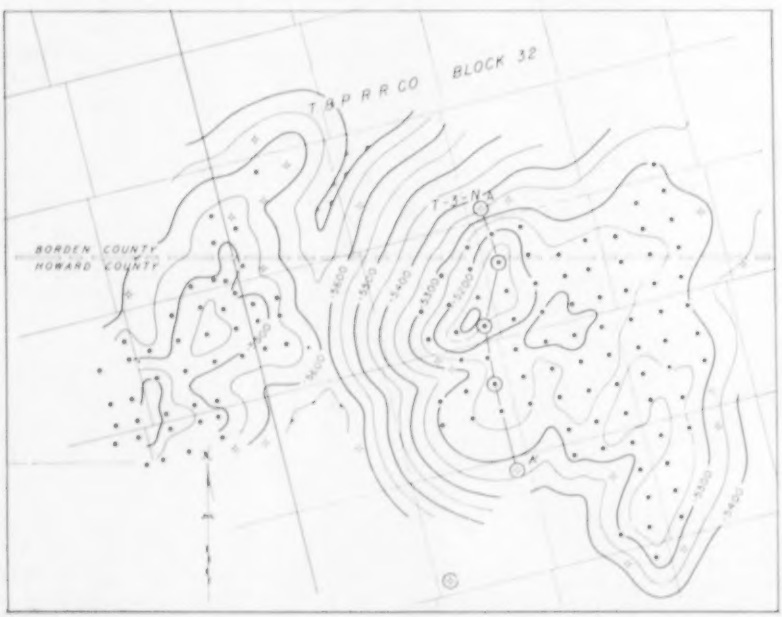

Fig. 5—The structure on top of the reef limestone is shown above. Cross section A-A' (Fig. 6) is located.

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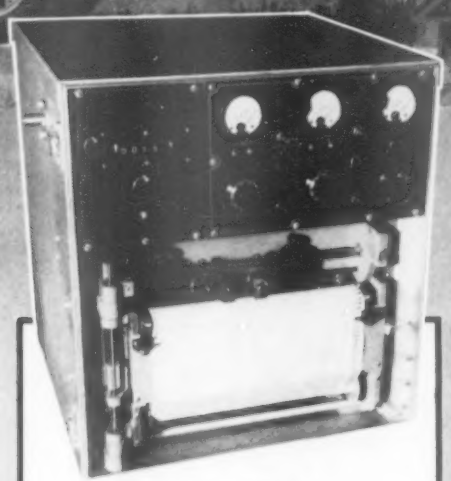

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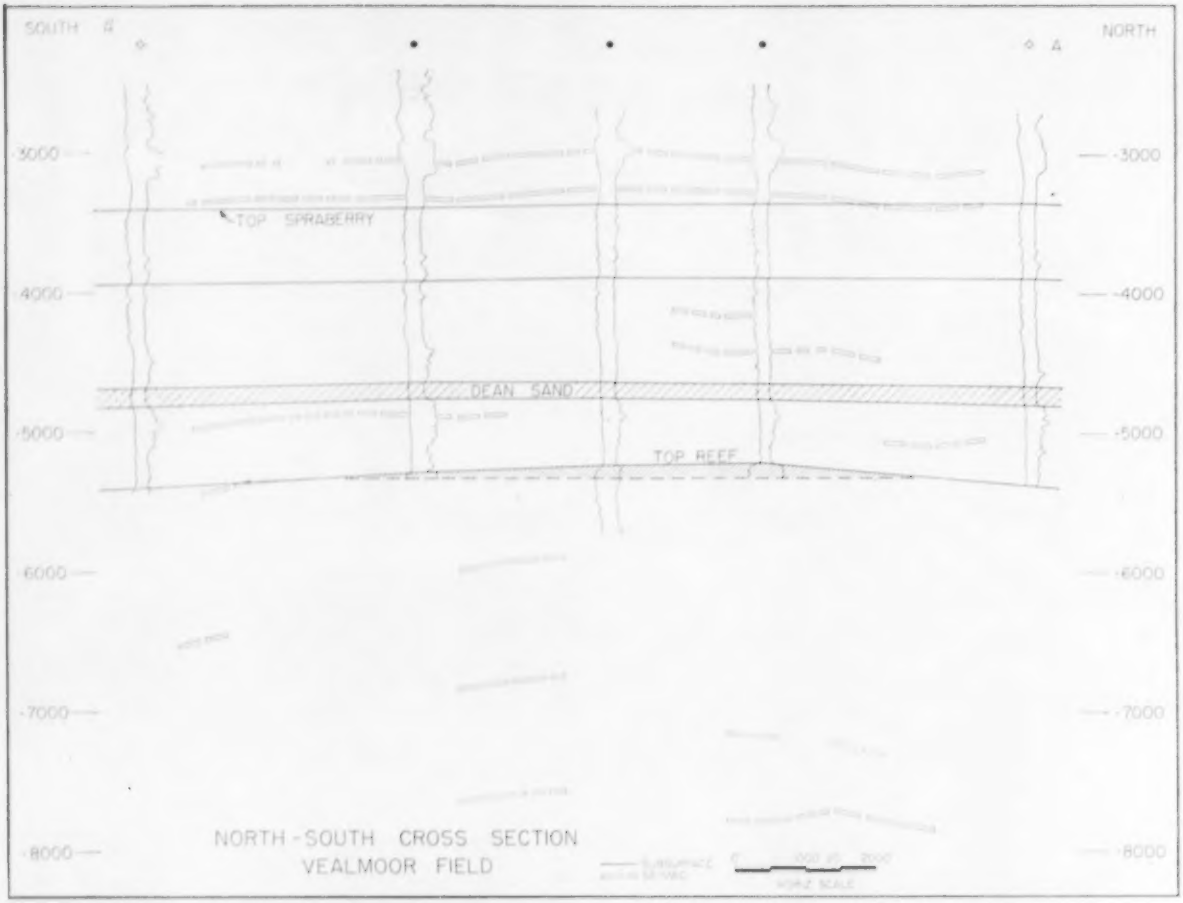

Fig. 6—A north-south cross-section through Vealmoor shows the relation between the seismic and subsurface data.

Exploration—McCarver

mic survey, which had a density of one shot point per 20 acres, obtained excellent reflection data from the Yates, fair reflection data from the Spraberry level, and only erratic information below the Spraberry. No consistent reflections were obtained in the vicinity of the reef, and the presence of a limestone "buildup" had to be deduced from draping and thinning in the lower Permian section. Typical seismograms are shown in Fig. 4.

Fig. 5 is a subsurface contour map of the "reef limestone." A fair relationship between seismic and subsurface contours can be seen by comparing this map to the one in Fig. 3.

Unfortunately, the seismic survey was limited to the east of Vealmoor and in the vicinity of Oceanic field; and the maps in these areas show a rather poor relationship.

It might be interesting to note that the isolated producing well in the northeastern portion of Oceanic field was drilled by Seaboard in March 1950, almost 3½ years before the actual discovery of the field. Two other tests, which are now above the oil-water contact of this field, found the reef hard and tight in this area and development was discontinued.

Fig. 6 is a north-south section across Vealmoor field, the location of which is shown in Fig. 5. This cross-section shows the relationship of subsurface markers to seismic reflections, and displays quite readily the accentuated "drape" of the Permian reflections over reef buildup. Although deep seismic data are quite scattered, it does show velocity "pullup" through the reef and indicated its possible presence.

Gravity survey . . . To determine the value of gravity as a tool for pin-pointing reef buildups, a detailed gravity survey was conducted in the Vealmoor area. Density studies and observed gravity data indicated that residual minima might be the key to reef identification, if any existed. Since subsequent development has shown that only 2 of the 12 or so residual minima shown in the Vealmoor area have a possible relationship to reef production, only limited use of this method has been prescribed.

Production history . . . As of January 1955, Vealmoor field had a total of 82 producing wells. The maximum amount of reef pay above water was 206 ft., the average thickness being approximately 88 ft. The accumulative production to January 1, 1955, was approximately 9 million barrels of oil and 9 billion cubic feet of gas.

Acknowledgments

The writer wishes to thank the managements of Seaboard Oil Co. and Comanche Corp. for permission to publish this paper.

THE AUTHOR

Holland C. McCarver is manager of the geological and geophysical department for the Mid-Continent area of Seaboard Oil Co. at Dallas. He attended University of Texas from 1931 to 1937, majoring first in business administration and then in geology. He was employed in 1937 by Geophysical Service, Inc., and remained with that company 7 years. In 1944 he joined Seaboard as chief geophysicist; he was promoted to his present position in 1954.

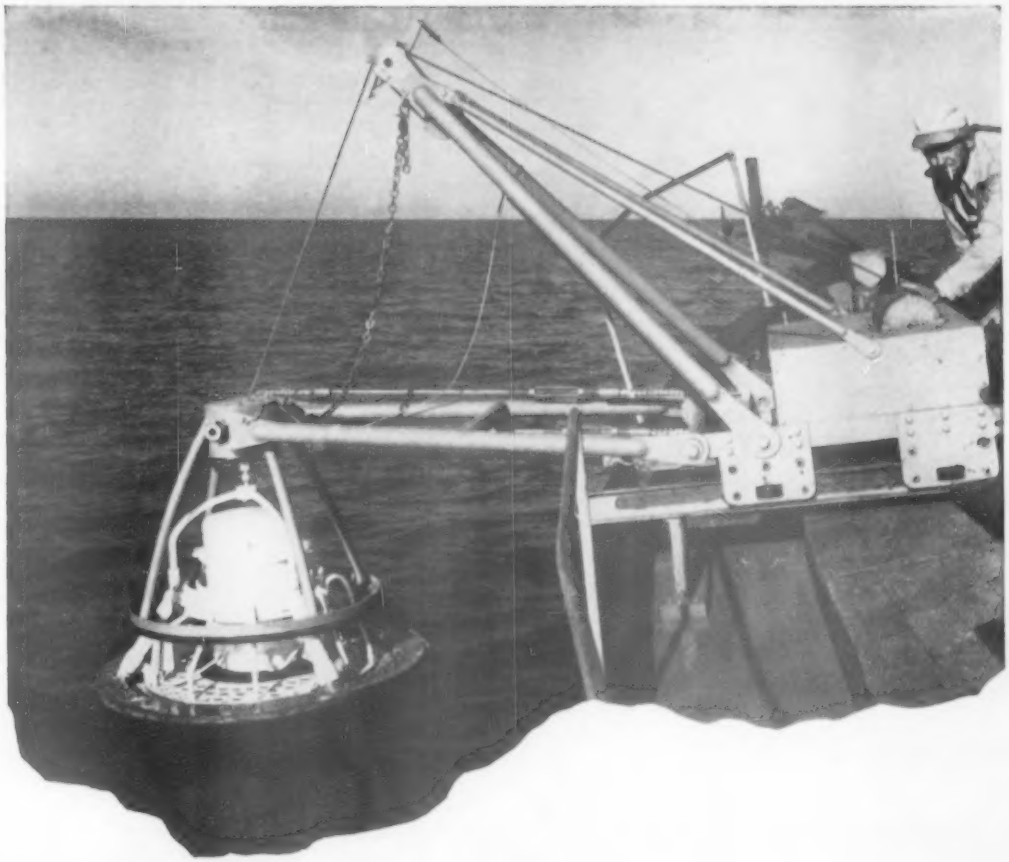

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Fig. 1—Discovery of Oil Creek production at Sandusky in 1950 ignited an aggressive search for similar structures in Grayson County, Texas.

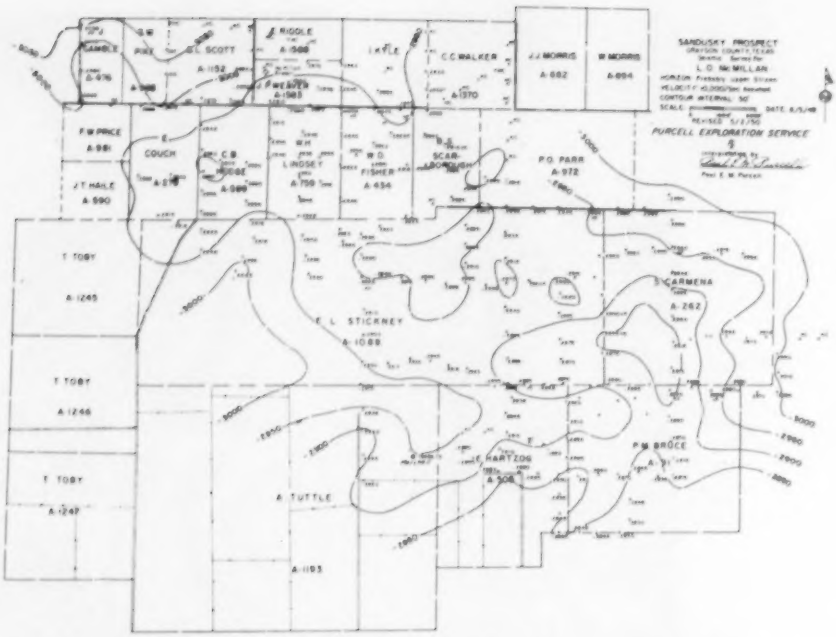

Fig. 2—The upper Strawn seismic map shows a low-relief anticline that weakly reflects the underlying Ordovician structure (Compare with Figs. 3, 4, and 5).

GEOPHYSICAL CASE HISTORY . . .

Sandusky Area, Grayson County, Texas

Since 1950 this has become one of Texas' most active areas

by Paul E. M. Purcell

SANDUSKY (Oil Creek sand) field was the first of a series of important Ordovician sand discoveries in Grayson and Cooke counties, Texas. The discovery of this and other Ordovician and Pennsylvanian pools in Grayson and Cooke counties was the direct result of seismic exploration. (Fig. 1).

Early drilling . . . Grayson County has long been considered an area favorable for oil accumulation. Early drilling met with little commercial success but served to keep interest alive. The first production was from Cretaceous rocks near the Pennsylvanian contact in the Pottsboro area. This was followed by limited development of Pennsylvanian production near Collinsville. The first production of importance was at Delaware Bend in extreme northwestern Grayson County where The Texas Co. completed its 2 Handy test in July 1946 for the discovery of an exceptionally good field in Pennsylvanian sand at a depth of less than 1,700 ft.

During the same year Standard Oil Co. of Texas drilled a deep test in the Sherman area. This resulted in a dry hole but definitely stimulated interest in the area and in 1947 this company opened the Sherman area for important Strawn production.

During the many years of wildcat drilling, shows were encountered in the Pennsylvanian in several wells. Before 1950 the only important production developed was from Pennsylvanian sands. However, the Ordovician was thought by some to contain attractive potential reservoir rocks, especially in the northwestern portion of the county.

Exploration . . . Early seismic work in the county leaned toward Pennsylvanian mapping. This resulted from a variety of causes: (1) Pennsylvanian rocks were known to be productive; (2) Pennsylvanian reflections were more numerous and generally more continuous than pre-Pennsylvanian reflections; and (3) the proper recording of Pennsylvanian and pre-Pennsylvanian events did not respond to the same technique.

As late as 1948 seismic studies by the author in Grayson County indicated severe and complex faulting in pre-Pennsylvanian rocks. But, inasmuch as the limited well control offered no proof of such complex faulting, the tendency was to confine the mapping to Pennsylvanian and Cretaceous rocks. This practice had continued even with the full knowledge that Pennsylvanian sand accumulation throughout North Texas, with few exceptions, was largely stratigraphic in origin, while Ordovician accumulation in neighboring southern Oklahoma was of structural origin.

Deeper pays . . . The possibilities of Ordovician accumulation had been recognized for many years. Certainly after the 1940 discovery of Cumberland field in Bryan and Marshall counties, Oklahoma, and the scattered few deep wild-

cats drilled in Grayson County, Texas, it was apparent that potential Ordovician reservoir rocks might be present in the region.

Early in 1949, L. O. McMillan began a serious search for Ordovician oil in western Grayson County. His first Ordovician test was the I J. R. Greer, in the J. P. Weaver Survey A-1383, near Sandusky. This well was completed in May 1949 as a dry hole. The well encountered oil shows in the Pennsylvanian and in the Oil Creek sand of Ordovician age. The Oil Creek was a very permeable and porous sandstone and was certainly a prize worth following. The sand thickness and character, the oil shows, and the unusual and encouraging reservoir pressure in the sand all helped to convince an already Ordovician-minded operator that an important oil accumulation might be found near this dry hole. It was evident that a thorough knowledge of Ordovician structure would help find this accumulation. In June 1949, Purcell Exploration Service, as contractor, was engaged by McMillan to conduct a seismic survey of the area. The operator requested an Ordovician map; Mr. McMillan emphasized that he could accept nothing less, even at the expense of possible inferior Pennsylvanian data.

Field work . . . The survey was started at the McMillan 1 J. R. Greer well, where Ordovician record quality was about as poor as any in the area. Preliminary attempts to secure adequate Ordovician control were discouraging. It later developed that the work was started with spreads obliquely across the largest fault in the area.

After moving south of the well it was possible to develop a technique that produced satisfactory Ordovician reflections. The preliminary work was done with continuous overlapping spreads with shot points spaced at intervals of 1,000 ft. For the most part

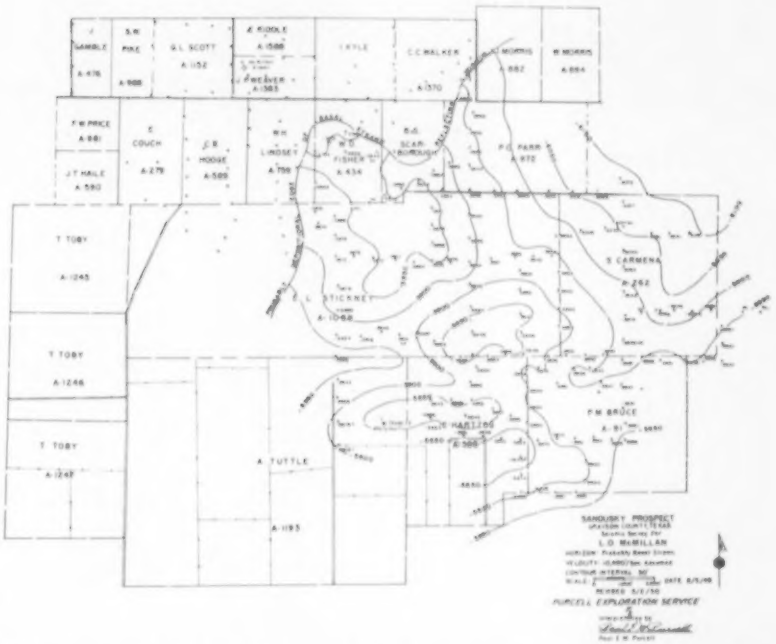

Fig. 3—This seismic mapping horizon was originally thought to be Basal Strawn, but is probably Dornick Hills in age. Notice that it shows greater relief than Fig. 2.

shot holes encountered only sandy clay of constant character, so with few exceptions a constant hole depth was employed. Three geophones connected in parallel were used per trace. These phones, spaced 5 ft. apart, were spread parallel to the line of profile at intervals of 160 ft.

Weathering corrections were made using the uphole method and all reflection times were reduced to a reference plane. At the time of the original survey no adequate velocity control was available (and even now it is very misleading due to the complex faulting cutting out high-velocity sections which are replaced by rocks of variable velocities).

Fig. 4—The Ordovician seismic map shows a folded and faulted trend with at least 200 ft. of relief whereas the upper Strawn horizon had less than 100 ft.

THE AUTHOR

Paul E. M. Purcell, coowner of the Purcell Exploration Service, Wichita Falls, Tex., is a graduate of University of Wisconsin. He began his career in oil exploration as a surface geologist and has been actively engaged in oil finding for the past 27 years. Purcell has had a broad experience in exploration work throughout West Texas, New Mexico, the Gulf Coast, Mid-Continent, Rocky Mountains, and western Canada. He has been engaged in the seismograph contracting business since 1944.

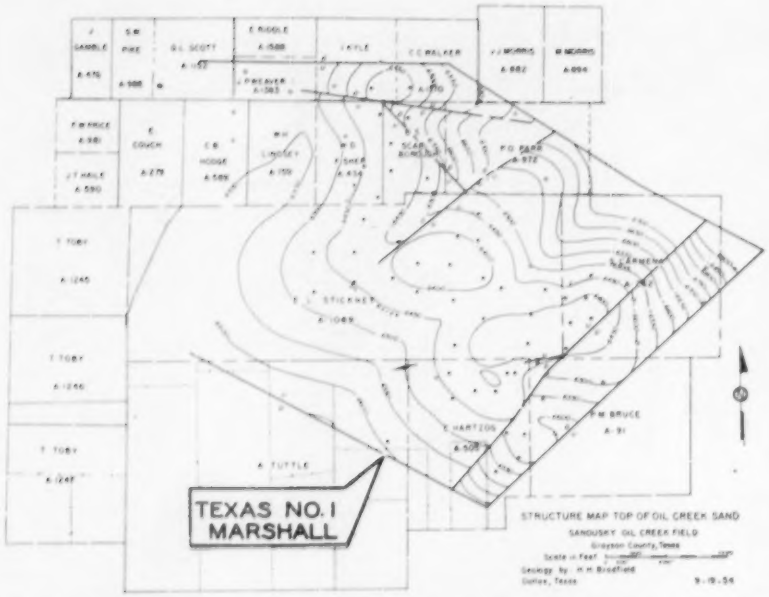

Fig. 5—The subsurface interpretation supports the original Ordovician seismic map (see Fig. 4); Sandusky is a complexly faulted anticlinal trend.

Mapping horizons . . . Early interpretations were based on the assumption that a persistent reflection at corrected times of 1,300 to 1,500 seconds represented top of Ellenburger. A computed velocity to the projected depth of Ellenburger at the McMillan 1 J. R. Greer well was 11,334 ft. per second. This, being the best control then available, was used to compute relative depths for the original Ordovician map. Later work and further study suggested that this event probably represented Joins rather than Ellenburger.

Two other fairly persistent reflections were mapped. These were thought to represent basal Strawn and upper Strawn. Subsequent development data suggest that the basal Strawn was probably Dornick Hills. Arbitrary velocities of 10,400 and 10,000 ft. per second respectively were used to compute relative depths used to map these two events. The following quotation is from the report on the Sandusky Prospect dated May 3, 1950, relative to the velocities used and the zoning of events: "Conflicting available measured velocities in the immediate area are basis of velocity used to the possible top of Ellenburger. It would seem probable that this mapped horizon is actually top of Joins lime, but, as such, would definitely conflict with reported measured velocities. Lacking first-hand velocity control, we feel confident that the horizon mapped is definitely of Ordovician age and is either basal Simpson or the top of Ellenburger. We also feel confident that the relative structural attitudes of the three mapped horizons are correct, and that the mapped Ordovician horizon is probably conformable with the Oil Creek sand as encountered at a depth of 7,395 ft. in the McMillan 1 J. R. Greer test."

Fig. 6—Although Sandusky was shot originally using closed loops, proper orientation of seismic lines is very important.

Seismic Results

Fig. 2 is a map contoured on an event with corrected reflection times of 0.683 to 0.731 second and was thought to represent upper Strawn. At the time there was considerable doubt about the over-all correlations and the widespread continuity of this event. There still remains such doubt and certainly some doubt about correlations and continuity of deposition within the Pennsylvanian. The original report stated: "The shallowest mapped horizon suggests a gentle arch with possible minor closures striking northwest across the prospect. Oil accumulation in lenticular Strawn sands may be found, and is anticipated along the crest of this gentle arch." The Sadler Pennsylvanian sand field has been developed from the southeast protion of this gentle fold southeastward along a projected axis.

Fig. 3 is a map contoured on what was originally thought to represent basal Strawn but what now would be called Dornick Hills. This map is based on corrected reflection times of 1.230 to 1.286 seconds. The lack of continuity of this event in the northwestern portion of the prospect was interpreted in 1949 as lack of deposition, but would probably now be considered the result of minor facies changes. Miscorrelation doubts that occurred in 1949 can and still do prevail, both in seismic and geologic correlations.

Fig. 4 is the most significant and probably the most accurate of the three mapped horizons presented. In 1949 this was considered top of Ellenburger and conformable with Oil Creek sand. This map led to the discovery of oil production from the Oil Creek sand at Sandusky and the subsequent wide-

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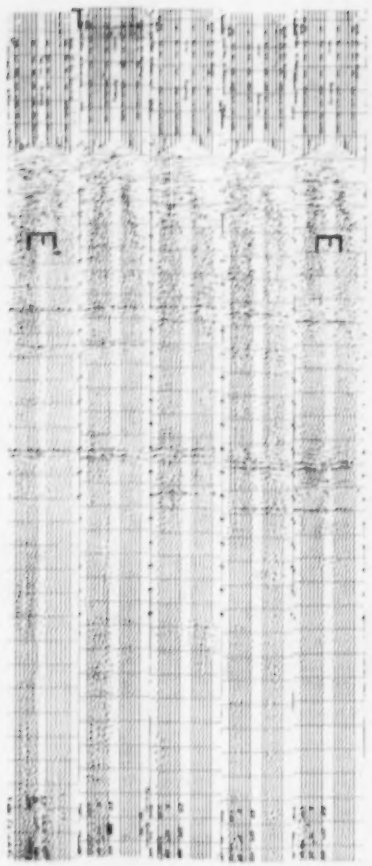

Fig. 7—Seismic line E-E' crossed a major fault at a high angle. Notice that the Pennsylvanian beds show steep dip across the fault over a wide area.

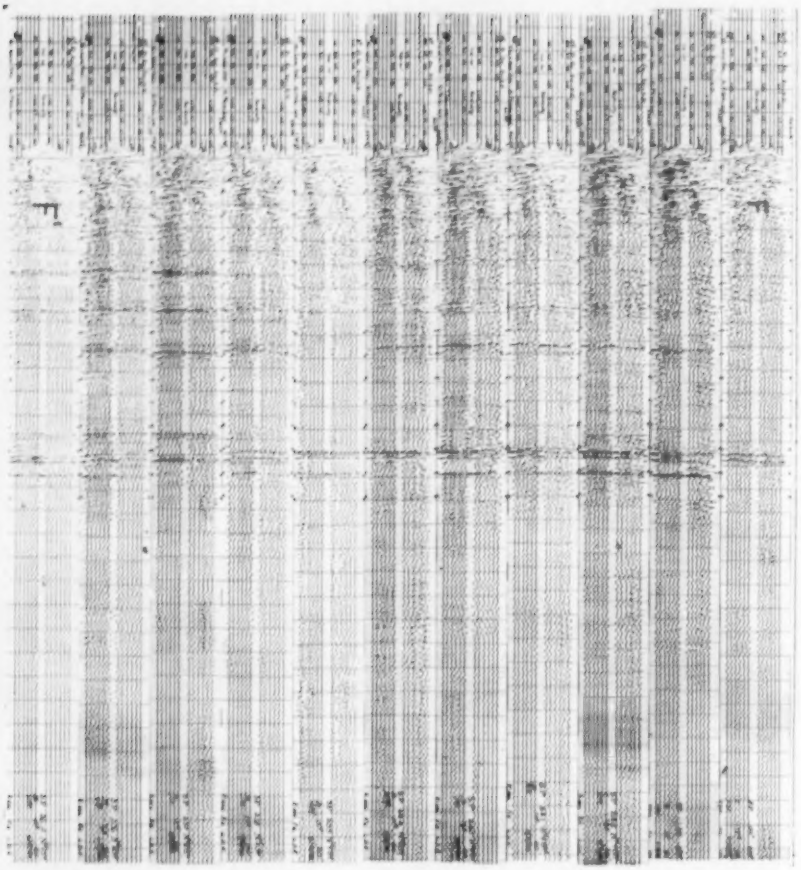

Fig. 8—Section F-F' was shot normal to the strike of the Sandusky structure. The record quality is fairly uniform and continuous.

Exploration—Purcell

spread exploration and development of a vast area in Cooke and Grayson counties, Texas.

The original seismic survey was completed in July 1949. The area looked attractive to the operator and, coupled with the oil shows in the well developed Oil Creek sand in his 1 J. R. Greer well, certainly warranted further testing.

During the succeeding months land problems were worked out. In the meantime The Texas Co. drilled its 1 John Marshall well south of Sandusky in the A. Tuttle Survey A-1193 (Fig. 5). This well encountered an excellent development of Oil Creek sand carrying water. The well was drilled to a total depth of 7,884 ft. in Ellenburger and ultimately completed in a porous zone in the Ellenburger for what was probably the first Ordovician oil production in Grayson County. Oil accumulation in this well is probably due more to stratigraphy than structure.

The results of The Texas Co. 1 Marshall well in no way hurt the Oil Creek sand prospects at Sandusky, for it was evident from subsurface and seismic data that its location did not place the well within the prospective area of the Sandusky structure.

Additional shooting . . . In April 1950, two additional lines were shot across the axis of the Sandusky fold (Lines F-F' and G-G', Fig. 6). The lines were run normal to the strike of the previously mapped Sandusky fold, and were added to further confirm the critical southwest dip. The additional lines did confirm the original interpretation and resulted in the revised maps here presented.

Sandusky field . . . On May 11, 1950, L. O. McMillan commenced his 1 J. C. Chambers well near the northeast corner of the W. D. Fisher Survey A-434. This well was completed July 20, 1950, as the Oil Creek sand discovery well of Sandusky field.

Development was rapid. It soon became evident that two limiting factors were involved in the accumulation of oil folding and faulting. Insofar as faulting was concerned, the two limiting faults had been clearly indicated by the original seismic survey. Minor faults within the producing area had not been recognized. The oil-water contact was established in the discovery well and the areal limits of production were indicated by the structural pattern established by the original seismic survey.

Comparison of seismic and subsurface data . . . Fig. 5 is taken from work by H. H. Bradfield and shows structural contours on top of Oil Creek sand from well data from the developed field. It indicates a pattern of folding and faulting that conforms well with the original Ordovician seismic interpretation (Fig. 4).

The major fault across the northern end of the seismic map was clearly indicated, the direction of movement properly interpreted, but the correlations across the fault were in error. Lack of control north of the fault and particularly lack of closed loops was largely responsible for these miscorrelations; but at the time it was concluded that the fault had definitely separated the northern portion from the prospective Sandusky structure. At the time of the original survey there was doubt about the correlation across

the faults, as evidenced by the following quotation from the original report: "This reflection does not conform too closely with earlier events and is, beyond any reasonable doubt, of Ordovician origin. We feel that this zone is cut by several major faults. The correlation of this event across each fault is, in every case, doubtful. Inasmuch as the survey is incomplete in the down-dropped areas, the structural attitude in the downthrown blocks may be very different from that herein indicated. However, we feel that the faults are present as indicated."

The northeast-southwest fault cutting the S. Carmena, P. M. Bruce, and E. Hartzog surveys was quite clearly and accurately picked. The other faults on the east and south edges of the area surveyed were based on inadequate control and did not stand up as mapped.

Fault criteria . . . Various criteria for fault identifications were noticed. Wells drilled close to faults encountered steeply dipping beds, as evidenced by crooked-hole trouble not experienced in wells located farther from the faults. These steep dips were sometimes present in the lower Pennsylvanian as well as in the Ordovician.

Seismic records from spreads at critical locations across faults indicated these steep and usually very local dips in many cases. In more cases such local steep dips were not evident, probably due to inferior record quality close to the fault break or to poorly chosen directions of spreads.

Naturally a clear suggestion of faulting was a break in the continuity of reflections. Such a break in continuity did not always mean faulting, and in many cases apparent continuity crossed faults.

An over-all deterioration of record quality often occurred along the faults. Spreads parallel to the faults were more susceptible to this than spreads normal to the strike of the fault.

. . . Seismic Section A-A' crossed a severely faulted area in the northwestern portion of the area originally surveyed. At the time this line was not tied into any loop and no satisfactory correlations were made. Faulting was, however, definitely indicated. This section showed local steep dips, breaks in continuity, and some deterioration of quality. Later detailed work proved this to be an area of very complex faulting with oil accumulation in Pennsylvanian rocks.

. . . Seismic Section B-B' crossed a major fault and shows very definite breaks in continuity. Some indication of local dip is evident, but record quality remains good—probably because the spreads are normal to the fault strike.

. . . Seismic Section C-C' crossed the same major fault near the McMillan 1 J. R. Greer well. This line crossed the fault at a high angle also and record quality remained good. The steep dips here are evident, though cover a wider area than usual. The breaks in continuity are quite evident.

. . . Seismic Section D-D' crossed the same major fault obliquely. Little clear evidence of steep dip is seen. Little or no continuity is seen. Certainly over-all record quality is very poor. This is a good example of a poorly chosen direction and poorly chosen location of shot points.

. . . Seismic Section E-E' (Fig. 7) crosses the same major fault at a high angle. Over-all record quality is good. Breaks in continuity are evident. Relatively steep dips in Pennsylvanian beds are seen across the fault over a wide area. Local steep dip in the Ordovician is not clear; this may be due to critical spacing.

Fault identification difficult . . . A study of the seismic sections all crossing the same major fault shows that no one criterion can be used or expected for localizing these faults. In many places in Grayson and Cooke counties important faulting has not resulted in so great a displacement. In

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many cases rocks of similar character and sedimentary succession are present on opposite sides of the fault and no clear break in continuity is evident. All the various known fault signals and more must be sought out and used. Early Ordovician interpretations were certainly retarded by the tendency to doubt confusing fault patterns. Today, with well control to support the fact that little rhyme or reason is connected with the complex Ordovician faulting, it becomes clear that only some of the faults in the shattered Ordovician section will be found with the best combination of subsurface and seismic mapping. But with these combined efforts it is probable that many more productive fault blocks will be found.

. . . Seismic Sections F-F' (Fig. 8) and G-G' cross the anticlinal axis of the Sandusky structure and continue down the southwest flank. These sections showed fair continuity, fairly uniform record quality, and no severe dips. Although these lines may cross minor faults, they are not too evident.

Although all of the Sandusky survey, as well as subsequent assignments in Grayson and Cooke counties, used continuous lines and closed loops, character correlation was important in all interpretations. The Ellenburger or Joins reflection remained fairly constant in character throughout the area. Wherever a thick Simpson section is present and over-all record quality is good, this reflection has sufficient identifiable character to be significant. In some fault blocks the entire Simpson section has been truncated, and it is possible within certain limits, not only to map these faults but to predict the absence of Simpson.

Another significant fact regarding the identifiable character of the outstanding Ordovician event is that, in all areas known to the writer where production has been found in the Oil Creek sand, this reflection is well developed and clear and of normal character.

The Ordivician oil found to date has been mostly the result of structural accumulation. While this search has been going on many important Pennsylvanian fields have been discovered. At least some of these have been the result of stratigraphic accumulation. It is clear that major Ordovician folding and faulting (even movement that never extended into late Pennsylvanian time) have caused breaks in the continuity of Pennsylvanian sedimentation. These breaks, together with proper structural position, have resulted in important Pennsylvanian accumulations. Some of this Pennsylvanian accumulation has been found as a very welcome byproduct of Ordovician exploration and found related to and associated with Ordovician structure with which Pennsylvanian beds no not necessarily conform.

Future exploration . . . Throughout a large area in Grayson and Cooke counties, Texas, and perhaps a larger area in the adjoining portions of southern Oklahoma, many more important oil fields will probably be found. Some Pennsylvanian fields will probably be found as primary Pennsylvanian prospects. Some portions of some of the presently known fault blocks will probably be productive in the Ordovician.

A continuing study of the subsurface, together with detailed seismic studies, will clear up many mysteries of Ordovician structure. It will also eventually clear up many of the mysteries of Pennsylvanian sedimentation, structure, and accumulation. Certainly much more will be learned in the future about both Pennsylvanian and Ordovician exploration in this area.

Acknowledgment

The writer expresses his appreciation to L. O. McMillan for his permission to publish this paper and for his making available the maps and records here used. Also, H. H. Bradfield for the subsurface map.

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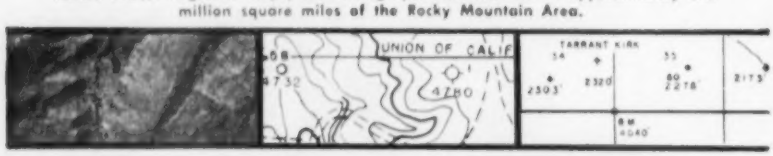

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Selected Digests . . .

. . . of papers presented at the joint annual meeting of the American Association of Petroleum Geologists, the Society of Exploration Geophysicists, and the Society of Economic Paleontologists and Mineralogists, New York, March 28-31, 1955.

A.A.P.G.

Petroleum Occurrence in the Uinta Basin

LEWIS F. WELLS, Sun Oil Co., Casper

THE Uinta basin is characterized by a preponderance of petroleum occurring within its geographic borders in Utah and Colorado.

The surface deposits such as the bituminous sandstones of the Sunnyside area along the Book Cliffs contain saturated sandstones with a crude-oil recovery of 94 per cent for an estimated reserve of 1.5 billion barrels. Along Asphalt Ridge at the unconformable contact of the Cretaceous and Tertiary are sandstones with a yield of 96 per cent for an estimated recovery of 20,500,000 bbls. per square mile and a total reserve of from 1 to 3 billion barrels of recoverable crude oil.

Solid and semifluid hydrocarbons such as the vein and fracture deposits of gilsonite, elbertite, wurtzlite, and ozocerite add to the potentiality of the basin. The kerogen shales of the Green River formation, particularly the Mahogany Marker unit, constitute one of the world's largest oil-shale deposits. This unit produces an average of 60-70 gal. of kerogen per short ton of shale and contains an estimated 400 billion barrels of reclaimable crude oil. New economic importance can be given the kerogen shales with the recent discovery of reclaiming them with a zinc catalyst. Great advancement can be expected in reclaiming the kerogen deposits of the Green River formation of the Uinta basin.

The subsurfaces of the Uinta basin also contributes to the petroleum reserve. Shows of oil or gas or both have been encountered in 95 per cent of the wells drilled within the basin. Daily production is approximately 75,000 bbl., the greater part of which is from Rangely. Rangely field has produced in 10 years approximately 140 million barrels of oil. Gas reserves for the Uinta basin are estimated at 575,000,000 M.c.f.

The general geologic features of the Uinta basin follow closely those of other Rocky Mountain areas having intermontane basins. The synclinal structure is moderately complex, with the axis trending east-west paralleling the anticlinal axis of the Uinta Mountains and is asymmetrical with the basin trough lying near the Uinta Mountain uplift. The structural form started in late Cretaceous and continued into late Tertiary time.

Paleozoic rocks 4,300 ft. thick represent all systems from Cambrian to Permian with the exception of Silurian. Mesozoic rocks 10,175 ft. thick of Triassic, Jurassic, and Cretaceous age are present with basin filling starting at the close of Cretaceous time. Lacustrine and nonlacustrine deposition continued through the Tertiary to late Miocene time. These continental beds 11,000 ft. thick contain a vast store of hydrocarbons and permeable sandstones which constitute large crude-oil reserves. The oil and gas reserves together with various forms of hydrocarbons and surface accumulation of petroleum require only further economic development to increase the resources of our nation.

Habitat of Oil in the San Juan Basin

SHERMAN A. WENGERD, University of New Mexico, Albuquerque.

THE San Juan basin is an ovate, frontal-intermontane, structural basin comprising about 20,000 sq. miles of area and 36,000 cu. miles of sedimentary rocks within the Dakota outcrop above the pre-Cambrian basement.

Oil in the San Juan basin is found in anticlinal, disconformal, and stratigraphic traps in the Ouray-Leadville-Hermosa carbonate rocks, and in anticlinal, terracic, disconformal, stratigraphic, fractural, and hydrodynamic traps in Entrada-Dakota-Mancos-Mesaverde-Farmington clastic rocks. With no proved exception, the oil in all strata of the San Juan basin is indigenous to the Paleozoic carbonate reservoirs, indigenous to Mesozoic sandstones or derived from shales superjacent and subjacent to clastic reservoirs, or indigenous to fractured Mancos shale and siltstone.

Considerable overlap of orogenic and hydraulic events occurred throughout the Cretaceous to Tertiary history of the San Juan basin. This resulted in slightly tilted water-oil contacts in anticlinal traps, downdip wedge-edge accumulations of oil, fault accumulations, and localized basinward shift of oil accumulations within presubsidence structurally closed traps. In some cases there resulted a complete shift from these traps to nearby structurally open areas where oil is held in dynamic balance by fresh water moving in complex patterns in relation to the present outcrops.

The San Juan basin area is considered to be only 50 per cent tested in post-Permian strata and 25 per cent tested in pre-Permian strata despite the fact that virtually all the surface anticlines have had at least one test drilled to Dakota rocks.

The Eastern Interior (Illinois) Basin As a Habitat for Oil

ALFRED H. BELL and **DAVID H. SWANN,** Illinois Geological Survey, Urbana.

AN oval 12,000-ft., 90,000-cu.-mile Paleozoic basin underlies 55,000 sq. miles of central and southern Illinois, southwestern Indiana, and western Kentucky.

With 63,000 wells and 27,000 dry holes, this basin has produced 2 billion barrels of oil in 50 years and is maintaining 0.8 billion barrels proved reserves despite annual withdrawal of 85 million barrels. Ultimately the upper half of the stratigraphic column will probably yield 3.5 to 4 billion barrels.

The lower half of the basin has not produced oil and is still virtually unknown. Except at the margin, only 11 wells with 6,000 ft. total penetration below St. Peter sandstone reach the 45,000± cu. miles of Upper Cambrian and Lower Ordovician rocks.

Oil in the Michigan Basin

GEORGE V. COHEE, USGS, Washington, and **KENNETH K. LANDES,** University of Michigan, Ann Arbor.

THE Michigan structural basin, which includes the Southern Peninsula and the eastern part of the Northern Peninsula of Michigan, parts of eastern Wisconsin, northeastern Illinois, northern Indiana, northwestern Ohio, and southwestern Ontario, was one of the first areas in the country to be explored for oil and gas.

Oil and gas occur in reservoirs on anticlinal folds that are the result of uplift and deformation during Paleozoic time. In the central basin area, northwest-southeast structural trends predominate, but in southwestern Michigan there appears to be no dominant structural trend. The oil and gas reservoirs are porous zones in limestone and dolomite of Middle Ordovician, Middle and Late Silurian, and Middle Devonian age; and sandstones of Middle Devonian and early Mississippian age. A small amount of natural gas has been produced from sandstone of early Pennsylvanian age. The porosity, permeability, and salt-water content of the limestone and dolomite reservoirs vary considerably in different producing areas and some of the producing zones are very lenticular.

Approximately 270 oil fields and more than 100 gas fields have been discovered in the Michigan basin. The size of the fields range from a few acres to more than 6,000 acres productive in oil and 11,000 acres productive in gas. The depth at which commercial production has been found to date ranges from 110 ft. in an old field in northern Essex County, Ontario, south of Lake St. Clair, to more than 5,000 ft. in the central part of the basin. The largest fields are in the central basin area.

It is estimated that more than 95 per cent of the oil produced has been from limestone and dolomite of Middle Devonian age. Most of the gas has been produced from sandstone of early Mississippian age; dolomites of Middle and Late Silurian age, however, have yielded large quantities of gas in southwestern Ontario and southeastern Michigan. Approximately 400 million barrels of oil and 330 billion cubic feet of gas have been produced from fields in the Michigan basin excluding the Lima-Indiana Trenton field at the southern margin of the basin, which has produced about half a billion barrels of oil and a large quantity of gas.

The Los Angeles Basin

WILLIAM F. BARBAT, Standard Oil Co. of California, San Francisco.

OIL was discovered in the Los Angeles Basin in 1880 and production to January 1, 1954, has been approximately 4.2 billion barrels of oil and 44 oil fields covering 39,583 acres, or 61.8 sq. miles. This represents an average recovery to date of 106,032 bbl. per acre. However, Long Beach field, with the most prolific production to that date, has averaged 499,175 bbl. per acre.

The drainage area of the Los Angeles Basin is estimated to be 850 sq. miles, which contains an estimated 2,000 cu. miles of sediment. There have been 1,453 new-field wildcat wells drilled to January 1, 1954, or at an average density of 1.7 wells per square

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mile. Wildcat density, of course, has been much greater through the more prospective portions of the basin. This, as well as seriously competing uses for the land, may lessen future exploration.

The possible extension of the basin under the waters of the Pacific Ocean may yield additional new oil, but there are serious technological, economic, and political handicaps to overcome before this may become a reality.

Oil in the San Joaquin Valley, California

RUSSELL R. SIMONSON, Ohio Oil Co., Los Angeles.

MORE than 6½ billion barrels of oil has been discovered in the San Joaquin Valley. Approximately 4¼ billion barrels has been produced and there is a reserve of 2¼ billion barrels. San Joaquin Valley oil fields account for 42 per cent of the annual production and contain 45 per cent of the reserves of the state.

Ninety per cent of the oil produced to date has come from rocks which are Miocene or younger in age. Nonmarine sediments, largely of Miocene or later age, have accounted for 1½ billion barrels of oil or 35 per cent of the total production of the valley. Oligocene and Eocene reservoirs are assuming importance as deeper drilling is done and new areas are explored. The pre-Tertiary sediments have accounted for less than 1 per cent of the oil produced. However, Cretaceous rocks are now being actively prospected.

The San Joaquin Valley is a synclinorium some 250 miles long and 50 to 60 miles wide lying between the Sierra Nevada Mountains to the east and the Coast Ranges to the west. The maximum depth to the basement is estimated to be in excess of 35,000 feet with the thickest sedimentary section being on the western side of the valley. Oil production is confined mainly to the southern portion which contains a thick section of organic Tertiary sediments.

In the San Joaquin Valley, oil is found in almost every type of trap. Anticlinal structures with complications either by faulting or stratigraphic changes have accounted for the major volume of production. Examples of this type of accumulation are fields on the Coalinga-Kettleman Hills anticline, the Elk Hills-Coles Levee anticline, the Rio Bravo-Greely trend, the Wheeler Ridge-Tejon Ranch anticline and the Belridge anticline. Oil occurs in faulted homoclines on the east side of the valley at Round Mountain, Kern Front, Fruitvale, Mount Poso, and Mountain View. Sands open to outcrop but with low fluid level produce at East Coalinga. The Lakeview area of Midway-Sunset field appears to be synclinal. Although sand is the reservoir rock for 95 per cent or more of the fields, significant accumulations also occur in fractured shales at Elk Hills and Buena Vista Hills and in fractured schist basement at Edison.

Inclined water tables have been noted in the Coalinga Nose, North Dome of Kettleman Hills, Paloma, Coles Levee, Elk Hills, and other fields. Advocates of the hydrodynamic theory are opposed by those who consider such inclined water surfaces due to differences in permeability. In some cases water encroachment is opposed to direction of inclination.

In the future, stratigraphic and fault traps should account for a larger percentage of oil discovered in the San Joaquin Valley than in the past. Obscure structural highs revealed

by subsurface geology, detailed geophysics, or other methods will undoubtedly contribute future discoveries. Recently, extensions and deeper drilling of known structures have accounted for substantial amounts of new oil and should continue to do so in the future.

The Denver Basin — A Stratistructural Province

C. J. McGINNIS, The California Co., Denver.

THE Denver basin covers some 58,000 sq. miles in portions of Colorado, Wyoming, South Dakota, Nebraska, and Kansas, and is directly related to the series of intermontane basins developed in the Rocky Mountain mobile belt during the Laramide revolution. Sediments, although preponderantly Cretaceous, range in age from Cambrian to Recent, and attain a maximum thickness of 15,000 ft. along the westerly asymmetric flank of the basin. While attention was focused on the area as early as 1862 with the discovery of oil in the Canon City, Colo., area, the current heightened activity stems from the discovery of significant reserves of Cretaceous oil in the Nebraska portion of the basin during 1949. Two productive horizons have been defined: the sands of the Cretaceous Dakota Group accounting for the great bulk of the production, and the Permian Lyons sand currently productive in but one field. With the general absence of adequate structural closure, stratigraphic traps assume the primary role. The considerable random drilling encouraged by low well costs has largely masked the material contribution made by scientific methods, but an alliance of these two exploratory approaches has greatly accelerated the development of the basin. The cumulative production to July 1954 was 51,382,000 bbl. The estimated reserve of 87,000,000 bbl. at the end of 1953 has been at least doubled by drilling during 1954, attesting to the youthful stage of exploratory development in the basin.

The Alberta Basin

D. B. LAYER, Imperial Oil, Ltd., Regina, Sask.

THE Alberta basin covers part of three provinces in western Canada, (1) British Columbia, (2) Alberta, and (3) Saskatchewan. It is 294,000 sq. miles in area and contains 410,000 sq. miles of sediments. As of August 1954, 8,371 crew-months of geophysical work have been carried out, 3,186 exploratory wells have been drilled, with the discovery of 120 oil fields and 29 gas fields. Oil reserves are estimated at approximately 2 billion barrels.

The keynote of the oil accumulations to date is that the major part of the oil (95 per cent) has been found in stratigraphic traps of two types (1) Devonian reefs and (2) Cretaceous sand pinchouts in a homoclinal area with dips of a degree or less. From a depositional point of view both types are developed in shallow shelf areas. The variations in stratigraphy were probably caused by shifts in basin shape and microtectonics in the immediate vicinity but these latter cannot be mapped structurally today.

The occurrence of the Devonian reef fields is discussed showing the relationship of these fields to the changes in shale carbonate ratios. The Viking sandstone is used as the example of Cretaceous sand pinchouts, and the oil and gas fields are shown with relationship to the Viking member itself and to the regional changes in sand thickness. As shown by isogravity maps a similar quality oil is found in both the Devonian reef and Cretaceous sands, and very little change occurs over a broad areal extent regardless of present depth of burial.

The similar types of crude are indicative of similar environments and tectonic history. Long-range vertical or lateral migration from a central source is probably not the answer. The ideal relationship of source and reservoir rock appears to be the association of relatively small anaerobic lagoons or embayments set up in a shallow sea by restriction of currents due to reef growth or sand bar developments.

Geology and Petroleum Possibilities of The Wind River Basin, Wyoming

R. M. THOMPSON, geologist and engineer, Denver

THE Wind River basin ranks third in cumulative oil production in Wyoming, and is also third in size. The stratigraphy and structure are fairly well known although much remains to be learned about the deeply filled Tertiary positions which account for 75 per cent of the area and over half the volume of the basin. Nineteen oil fields, six of which produce gas, plus three additional gas fields have been discovered along the well-exposed west and south margins of the basin. These fields have produced over 86 million barrels of oil plus about 100 billion cubic feet of gas. Oil reserves are known to approximate 163 million barrels. With 75 per cent of the basin virtually unexplored it is reasonable to assume that many good oil fields remain to be found.

The great volume of Tertiary rocks, almost unexplored, contains oil-saturated sands on many outcrops and in several wells that have penetrated the section. Gas has also been found, but not produced, in some of these sands. Major unconformities exist within the Tertiary and below it and may have trapped oil and gas in commercial quantities. These rocks offer great future potential in both stratigraphic and structural traps. Beneath the Tertiary several thousand feet of Upper Cretaceous rocks, mainly Mesaverde, upper Cody, and Frontier, have barely been explored. Thick porous sands within these formations lens out in short distances. Some of the Paleozoic formations also offer a challenge, such as the Madison limestone, untested on many known structures. One reward for deeper drilling to evaluate older rocks is the expected increase of gravity. Most of the younger rocks carry high gravity oils regardless of depth.

Entrapment of oil in the basin under hydrodynamic conditions may become an important part of future exploration. Also of

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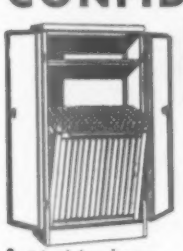
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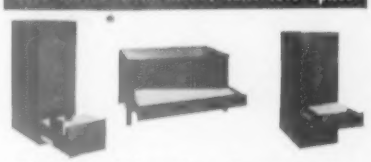
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Exploration—Digests

future importance is the conservation of reservoir energies and secondary recovery.

Geologic Pattern of Oil Occurrence in The Powder River Basin

BRUCE F. CURTIS, Continental Oil Co., Denver.

ONE of the largest of North American oil basins is the Powder River basin of northeastern Wyoming and southwestern Montana. It extends over nearly 37,000 sq. miles and is covered by sedimentary rocks which average more than 1¾ miles in thickness. The basin is structural and topographic rather than of the paleodepositional type. Petroleum was first discovered in the Powder River basin in 1889. Since then it has produced more oil than any other Rocky Mountain area.

The basin's axis is close to its folded west flank. Its gentle east limb lacks notable folds.

The pattern of oil occurrence is closely related to the Powder River basin's geologic history. Sedimentary rocks whose ages approximate those of the two orogenic periods are believed to have furnished both the sources and the reservoirs for most of the petroleum.

The most prolific oil fields are in the folded and faulted traps on the basin margins. However, there are some important recently developed fields of the stratigraphic kind whose traps depend mainly on permeability variations in Cretaceous sediments. Areal and depth patterns imply that oil pools accumulate in the geologic history of the basin.

Cognizance of the prevailing patterns exhibited by producing fields should help continue the success of oil finding in the Powder River basin.

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The Habitat of Oil in the Canadian Portion of the Williston Basin

G. B. DARLING, Imperial Oil, Ltd., Calgary, and **P. W. J. WOOD,** Imperial Oil, Ltd., Regina

IMPORTANT oil pools have been discovered on the northeastern and northwestern flanks of the Canadian portion of the Williston basin. The flanks are stable shelf areas of thin sediments, facies changes and rapid sedimentary truncation. It is in these stable, almost structureless shelf areas that the bulk of the oil is pooled. Although the present major reserves are located on these shelf areas and restricted to Mississippian, Jurassic, and Lower Cretaceous rocks, the basin is complicated by earlier configurations, in particular, the transverse Middle Devonian salt basin.

Oil accumulations in the Canadian portion of the Williston basin apparently have not been affected by salt tectonics or recent uplifts such as the Bowdoin dome. The pools are essentially stratigraphic traps closely associated to the Mississippian and Jurassic unconformities. Minor tectonics in late Mississippian, Jurassic, and early Lower Cretaceous time have localized these accumulations. This is in sharp contract to the United States portion of the Williston basin where the major pools are restricted to Paleozoic rocks and a number of tectonic structures are readily recognized and well known.

S.E.G.

Interpretation of a Geophysical Prospect

R. W. MOSSMAN, Seismograph Service Corp., Tulsa.

IN interpreting geophysical data it is essential to incorporate information on the geologic conditions characteristic of the area of the prospect. An analysis of the data on a purely geophysical basis can lead to very erroneous conclusions. As an illustration, a case history of a seismic prospect in a faulted area is presented, showing successive changes in the interpretation as additional geologic information is introduced into the evaluation. From an economically attractive graben, the interpretation is developed to show that a horst of even greater apparent potential is actually present, which is finally shown to be a very undesirable drilling site.

Planning a Geophysical Program for an Unexplored Basin

T. J. O'DONNELL, Gulf Research & Development Co., Pittsburgh.

THE ideal geophysical program for an unexplored basin would use magnetics, gravity, and seismograph to provide an orderly flow of information leading successively to the determination of the over-all form of the basin and its chief structural elements, to the delimiting of areas worthy of detailed study, and ultimately to the selection of drilling locations.

Examples are presented which suggest that these objectives can be obtained most efficiently by planning the program to obtain data of adequate density and precision to permit quantitative interpretation. Geological data and speculation should be made immediately available to the geophysicists so that interpretations can be constantly reexamined in the light of new information and the program modified accordingly.

Geophysical History of Sharon Ridge Canyon Field, Scurry County, Texas

ROBERT C. STONE, Humble Oil & Refining Co., Midland, Tex.

THE Humble Oil & Refining Co.'s early geophysical exploration effort in the Sharon Ridge area included a reconnaissance gravity-meter survey in 1937 and a reconnaissance reflection survey in 1938. In 1949, following the discovery of Sharon Ridge Can-

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yon field, a detailed reflection survey was made of the entire southwestern portion of Scurry County. The results of the gravity meter and seismic work are compared with the reef structure that is revealed by present subsurface control.

Conversion of reflection time to depth is accomplished by means of a local velocity gradient map.

Simultaneous Gamma Ray and Resistivity Logging as Applied To Uranium Exploration

R. A. BRODING and **BEN F. RUMMERFIELD**, Century Geophysical Corp., Tulsa.

THE transferring of petroleum exploration thinking and methods to uranium exploration has greatly facilitated the search for radioactive ores. The application of radioactive and resistivity logging to locate mineralized zones in shallow core holes obviates the need and expense of taking continuous cores. Instrumentation, field equipment, and techniques are discussed.

Results of Airborne Radioactive, Electromagnetic and Magnetic Surveys

HANS LUNDBERG, Hans Lundberg, Ltd., Toronto.

AIRBORNE recording of radiation from the earth's surface is a new method of geological mapping. After eliminating effects from topography, surface waters, and known geology, a pattern often remains that may enable the geologist (geophysicist) to outline direct indications of oil and gas accumulations which apparently have a blocking effect upon upward trending movements. The position of radioactive mineral deposits may also be revealed directly in detail surveys, and it is also possible to distinguish the effect of uranium from that of thorium and potassium.

In sedimentary regions airborne electromagnetic surveys may reveal underlying structures down to 1,000 or 2,000 ft. by recording the effects of secondary fields created in good conducting layers by a transmitter in the plane. In order to outline deposits of conductive bodies of mineralization, current is supplied to the ground by means of very long cables with enough effect to directly outline the conducting bodies at depth from airborne recordings.

Airborne recording of the total magnetic field over very large areas greatly assists geological mapping. For detail studies the recording of the vertical component at low altitude is found to be an excellent method of outlining magnetic ore bodies and zones of mineralization, particularly in the pre-Cambrian formations.

Acoustic Logging and Its Geophysical and Geological Applications

H. R. BRECK, S. W. SCHOELLHORN, and **R. B. BAUM,** Seismograph Service Corp., Tulsa.

ACOUSTIC logging, as a general service to the oil industry, is less than a year old. Even with this short period of experience, a number of observations can be made which indicate that the acoustic log will make some valuable contributions to the total of information obtainable from a drilled hole.

The most obvious application of the acoustic log is the replacement of the conventional velocity survey. Data obtained are comprehensive and accurate.

From the standpoint of the geologist, the acoustic log provides another correlation medium. The log is derived from a heretofore unmeasured physical property and hence emphasizes variations not measured by other logs. A qualitative correlation of relative porosity with some velocity changes seems obvious.

The Composition of Reflections

J. P. WOODS, Atlantic Refining Co., Dallas.

THE reflection seen on a seismic record is often a composite of several reflections. The interpreter thinks that he deals with a single interface, when in reality, he is dealing with a number of close-spaced reflecting layers. If the arrangement of these layers changes, the composite reflection seen on the record will change in time of occurrence and in character. In consequence, the horizon carried by the interpreter will be in error. To demonstrate this composition of reflections, a simple acoustical model has been built and various records made with this model will be shown.

The Reynolds Plotter

VINING T. REYNOLDS, V. T. Reynolds, Inc., Houston, and **PAUL FARREN,** National Geophysical Co., Inc., Houston.

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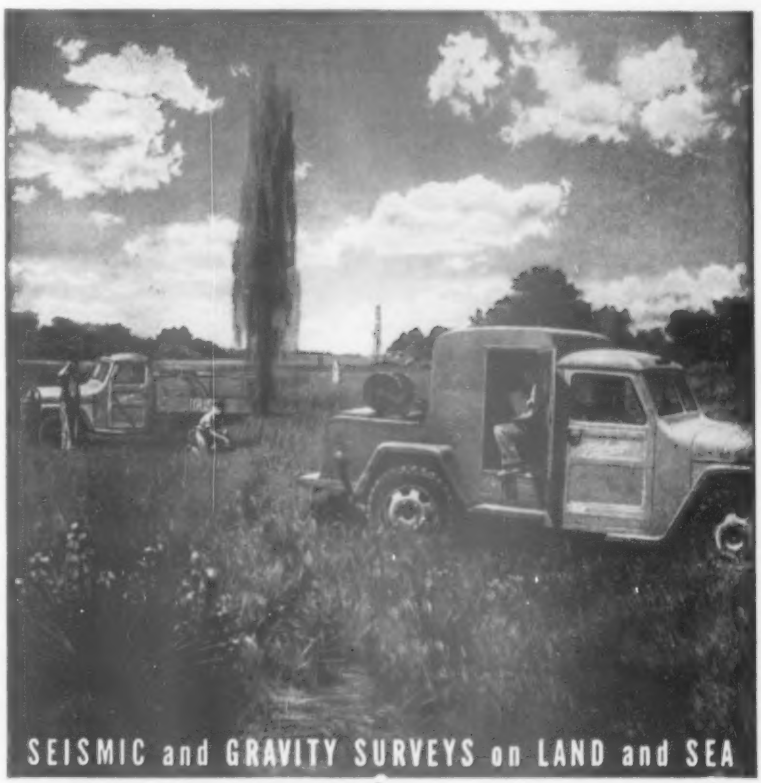

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S.E.P.M.

Subsurface Geology of Coke County, Texas

SAMUEL P. ELLISON, JR., University of Texas, Austin.

AN array of facies changes, reef masses, and porosity pinchouts dominate the gentle westward-dipping Pennsylvanian and Permian strata. Faulting and folding create complex petroleum reservoir-finding hazards in Cambrian and Lower Ordovician beds below the basal Pennsylvanian angular unconformity along the Bronte uplift in the eastern part of the county. Buried cuestas and isolated hills of the pre-Pennsylvanian topography also account for some reservoirs.

Wildcat-well density has now reached the point where modern electrical logs become efficient tools for solving lithologic problems and stratigraphic correlations. The trend patterns of facies, reefs, porosity pinchouts, buried topography, faults and folds are applicable to the search for petroleum in adjacent counties on the eastern shelf and Concho arch.

Salt Dome Stratigraphy—Lower Gulf Coast

SHEPARD W. LOWMAN, Rensselaer Polytechnic Institute, Troy, N. Y.

THE stratigraphy of salt domes is divisible into (1) regional stratigraphic setting of the domes and (2) characteristic effects produced by domes on local stratigraphy. Under the regional category an attempt is made to distinguish those features which are essential to salt-dome formation. In the local class the effects produced by shallow and deep-seated domes are considered. Discussion is limited to lower Gulf Coast of Texas and Louisiana.

Starved Basins

HUGH N. FRENZEL, Midland, Tex.

A STARVED basin is defined as a basin which received a thinner section of deposits than adjoining areas, because the rate of subsidence was materially greater than the rate of deposition. In contrast to ocean basins which have remained starved over long periods of time, intracratonic basins, that show these characteristics, were starved for only portions of their history.

Typical and well-known examples are the upper Pennsylvanian Midland basin and the upper Guadalupe Delaware basin. These basins illustrate the range and variation in basins which are called starved. A starved basin condition existed in the Midland basin during upper Pennsylvanian time as shown by the thin black shale section which grades into a thick section of limestone around the margin. The upper part of the Guadalupe series in the Delaware basin is interpreted as a starved basin deposit because these rocks are thinner than the correlative reef and shelf sediments and were deposited 2,000 ft. below them.

A basin becomes starved when the supply of clastics is restricted by such factors as distance from source, intervening basins or troughs, and the inability, because of increasing depth, of normal waves and currents to carry their traction load beyond the basin margin.

Spores and Pollen—a New Stratigraphic Tool for the Oil Industry

RAYMOND D. WOODS, Humble Oil & Refining Co., Houston.

INTEREST in the use of spores and pollen as a stratigraphic tool has recently been accelerating in the oil industry. It has been demonstrated in a number of areas that the distribution of these fossils is adequate for stratigraphic work and several major companies now have full-time paleobotanists on their research staffs. Certain of these windblown fossils offer a distinct advantage in permitting correlation of strata deposited under ecologic conditions unfavorable for the distribution of marine or fresh water animals. Certain other forms have been suggested as indicators of depositional environments. In addition, current research on spores and pollen has revealed the distribution of heretofore little-known microfossils, particularly the "hystrichs" which are proving to be as useful as plant remains in stratigraphic work.

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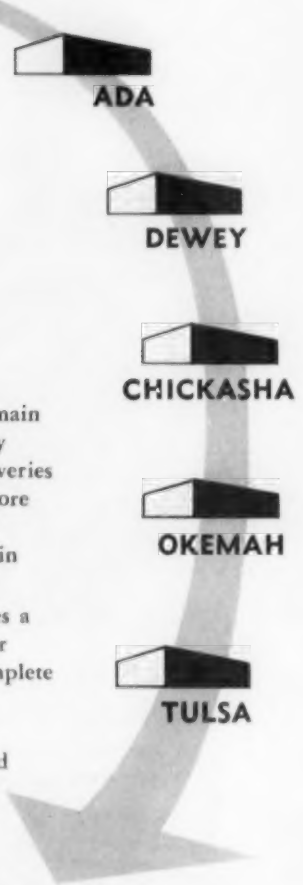

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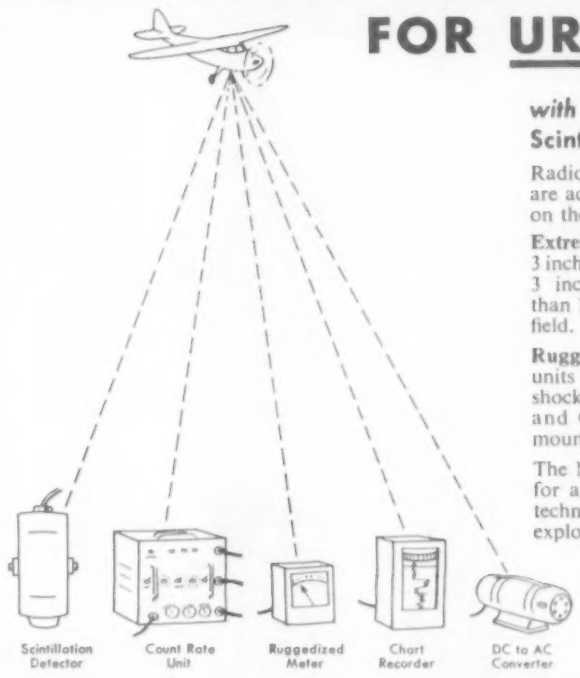

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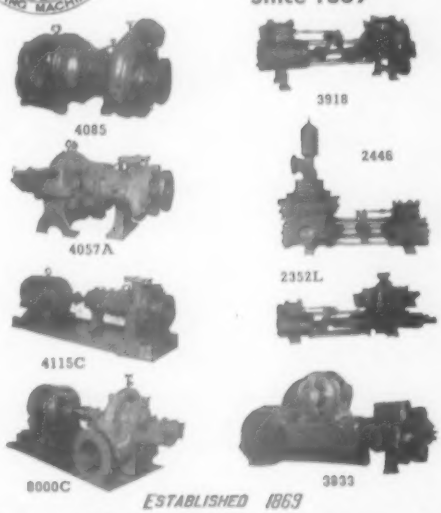

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Use of Stabilizers in Drill-Collar String

. . . to speed drilling in crooked-hole country

As authors summarize the technique . . .

1. Stabilizers are one good way to combat crooked holes; there are also other good techniques. Therefore, always consider using one or more of these in addition to the stabilizers:

- Deliberately accepting more deviation.
- Using larger than conventional drill collars.
- Drilling a larger than conventional hole and using larger than conventional collars.

2. The use of one stabilizer gives these advantages:

- With one stabilizer, more weight may be carried without increasing hole deviation. The additional weight is about 20 per cent for very crooked formations and up to 50 per cent for other formations.
- You can get about the same advantage by using a stabilizer with the maximum size of collars that can be washed over as with oversized collars without a stabilizer. This conclusion is important in cases where oversized collars are not desired.
- More weight may be carried with oversized collars and a stabilizer than with oversized collars alone. This conclusion is important where oversized collars may be used without undue risk.

3. There are several obvious disadvantages to using stabilizers, such as the increased danger of sticking and fishing. This danger, incidentally, may be greatly reduced by using rubber stabilizers. Besides these obvious disadvantages which are not discussed in this paper, there are others:

- The stabilizer must be placed within a few feet of a definite position, given in the accompanying charts. Therefore, the use of a sub is necessary. Failure to properly locate the stabilizer can explain the frequent lack of success in the past.
- It may be necessary to change the stabilizer position a few times during the drilling of a well. All possible positions may be approximated closely enough with a maximum of four subs of different lengths on the rig, only one of which is used at a time. In most cases, however, one or two subs would suffice.

4. The use of several stabilizers closely spaced from the bit, or the use of reamer and stabilizer, will result in a continued buildup of angle. Deviation may eventually become excessive. Such practices, however, may be useful as a means of reducing the **rate** of buildup angle before the maximum acceptable angle is reached.

by H. B. Woods* and Arthur Lubinski†

MANY past attempts to drill faster in crooked-hole formations by using stabilizers in the drill-collar string have failed. The reason for failure was that no one knew exactly where the stabilizers should be placed and what weight could be carried on the bit. This article tells exactly that.

The charts with this article will show you how much more weight you can carry on the bit with a stabilizer than without one. They will also show you where the stabilizer should be placed in the drill-collar string. These charts are already in field use.

In the past, use of stabilizers has sometimes been successful and sometimes disappointing. The problem is so complex that it seems impossible from field experience to establish rules for the successful use of stabilizers. For this reason, a theoretical investigation was made jointly by the research departments of Hughes Tool Co. and Stanolind Oil & Gas Co. The numerical work involved lengthy equations. Solving them required a digital computer. The I.B.M. programed electronic calculator at the Stanolind Research Center was used.

In this study the effects of rotation are disregarded. The justification for this is that the same assumption made in the past[4,5] led to results in agreement with field experience.[6,10]

General Effect of a Stabilizer

Consider a drilling string in an inclined hole, as shown in Fig. 1A. Near the bit, the string does not contact the wall of the hole. At some distance above the bit, the drilling string contacts the wall. Above the point of contact the string lies on the low side of the hole.

With no weight on the bit, the only force acting on the bit is due to the weight of the portion of the string between the bit and the point of contact. This is a beneficial force because it tends to bring the hole toward vertical.

When weight is applied, there is another force which is detrimental. It tends to direct the hole away from vertical.

Suppose a stabilizer is used, as shown in Fig. 1B. The point of contact is now at the stabilizer, which is higher than the point of contact in Fig. 1A. Thus, the above-mentioned beneficial force is greater. In addition, although it is difficult to visualize, the detrimental force is normally smaller. This explains the usefulness of a stabilizer.

Where to place it . . . Fig. 1B suggests that the best position of a stabilizer is as high as possible provided the collar does not contact the wall of the hole, as in Fig. 1C. In fact, mathematical study shows that in most cases the optimum position of a stabilizer is as in Fig. 1C. In some cases, however, the optimum position is somewhat lower, as in Fig. 1B.

The optimum position of the stabilizer in the string depends on the size of collars, size of hole, hole inclination, and weight on bit. It does not **directly** depend on formation

*Hughes Tool Co., Houston, and †Stanolind Oil & Gas Co., Tulsa. Paper presented at Mid-Continent district meeting, A.P.I. Division of Production, Amarillo, March 23-25, 1955.

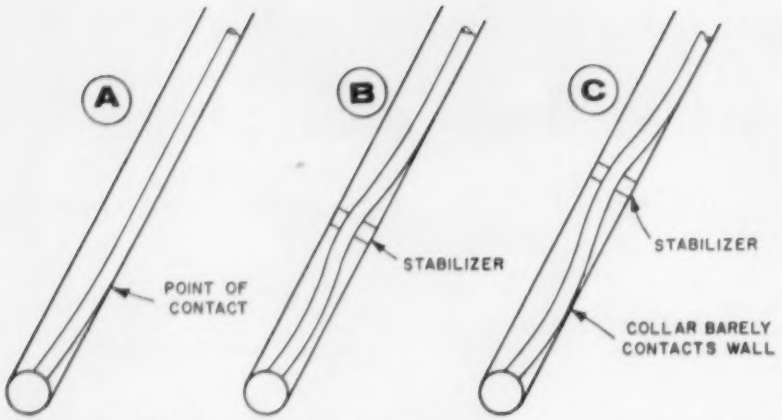

Fig. 1—In most cases the optimum position for a stabilizer is at the position "C." In some cases position "B" is better.

crookedness and formation dip; but it **indirectly** depends on them since these are factors which govern the weight that may be carried.

Benefit Derived From Using a Stabilizer

Stabilizers are used in different combinations with or without reamers. In this section, we will consider the benefit to be expected from a single stabilizer.

Assume first that there is no clearance between the stabilizer and the hole. The influence of clearance will be investigated farther in the article.

Assume furthermore that, for given hole and collar sizes, it is known how much weight may be carried without a stabilizer for a given hole deviation. Such knowledge may be directly provided by previous drilling experience in the field. Also it may be calculated with practical charts[5] if the field experience is for some other combination of collar size, hole size, etc. Let us find how much more weight could be carried if a stabilizer were placed at the ideal position. The answer is given by the lower diagrams in Figs. 5 to 20.

Drilling example . . . Assume we are drilling an 8¾-in. hole with 8-in. collars and no stabilizer. There is 50,000 lb. on bit, and the formation is such that hole deviation is 10°.

Then, Point A, Fig. 10, shows that, using a stabilizer at the ideal position, 29 per cent more weight could be carried without increasing hole deviation. This percentage of additional weight which may be carried without increasing angle we will call "percentage improvement."

The charts, Figs. 5 through 20, are for the most popular hole sizes and various collars. These general conclusions may be drawn from the charts:

1. In very severe crooked-hole formations, where very light weights are carried, the percentage improvement is of the order of 23 to 26 per cent. As examples of this, take Point B of Fig. 10 (for packed holes) and Point C of Fig. 11 (for conventional clearances).

In very mild crooked-hole formations, where heavy weights are carried, the percentage improvement depends on hole clearance. For packed holes in most cases, it is 30 to 40 per cent, as shown by Points A and D in Fig. 10. For conventional clearances, the percentage improvement is from 40 to 80 per cent. As examples of this take Points E and F of Fig. 11.

Stabilizer Versus Collar Size

How much benefit we gain by increasing collar size we already know.[5] How much benefit we gain by use of a stabilizer we discussed in the preceding section. Now we will compare the two benefits.

Severely crooked formation . . . As an example of a very severe crooked-hole formation, assume we are drilling an 8¾-in. hole with 6-in. collars and no stabilizer. With 3,700 lb. on bit, the formation is such that hole deviation is 3°.

Using practical charts,[5] we may find the weight we could carry if other collar sizes were used. Then, with Figs. 5 to 20 in this paper, we may find the weight for each collar size if a stabilizer were used. Thus, we prepare Table 1.

TABLE 1

Collar size (in.)	Weight to maintain 3°: Without stabilizer (lb.)	With stabilizer at optimum position (lb.)
6	3,700 (A)	4,600 (B)
7	5,000 (C)	6,300 (D)
8	5,900 (E)	7,400 (F)

Moderately crooked formation . . . As an example of moderate crooked-hole formations, assume we are drilling an 8¾-in. hole with 6-in. collars and no stabilizer. With 19,000 lb. on bit, the formation is such that hole deviation is 3°.

Then, by the same means as above, we prepare Table 2.

TABLE 2

Collar size (in.)	Weight to maintain 3°: Without stabilizer (lb.)	With stabilizer at optimum position (lb.)
6	19,000 (A)	27,500 (B)
7	30,000 (C)	41,800 (D)
8	42,500 (E)	56,500 (F)

Several similar examples were worked out for formations of various degrees of crookedness and for various hole sizes. From them we draw these general conclusions:

1. As indicated by comparison of situations (D) and (E), Tables 1 and 2, about the same weight may be carried:

(a) With no stabilizer and oversized collars.

(b) With a stabilizer and the largest collar size that can be washed over.

2. As indicated by comparison of situations (E) and (F), Tables 1 and 2, if oversized collars are used, using a stabilizer gives us additional advantages.

3. As indicated by a comparison of situations (B) and (D), Tables 1 and 2, in crooked-hole drilling we should avoid the use of collars any smaller than the maximum size which may be washed over.

Ideal Position of Stabilizer

As in the previous section, assume for the time being that there is no clearance between the stabilizer and the hole. The upper diagrams in Figs. 5 through 20 give us the ideal position of a stabilizer.

Drilling example . . . Assume we are drilling an 8¾-in. hole with 8-in. drill collars and one stabilizer. With 20,000 lb. on bit, the formation is such that hole deviation is 4°.

Then, Point G, Fig. 10, shows that the ideal position of a stabilizer is 69 ft. above the bit.

Most of the curves are limited to the right by a dashed line. In this case any curve must be considered to follow the dashed line downward, as shown in the example below.

Another example . . . Assume we are drilling an 8¾-in. hole with 6-in. drill collars and one stabilizer. With 40,000 lb. on bit, the formation is such that hole deviation is 3°.

Then, Point H, Fig. 11, shows that the ideal position of a stabilizer is 56 ft. above the bit.

Conclusions on ideal position . . . Figs. 10 and 11 (or, more generally, Figs. 5 to 20) lead us to these general conclusions:

1. The ideal position of a stabilizer

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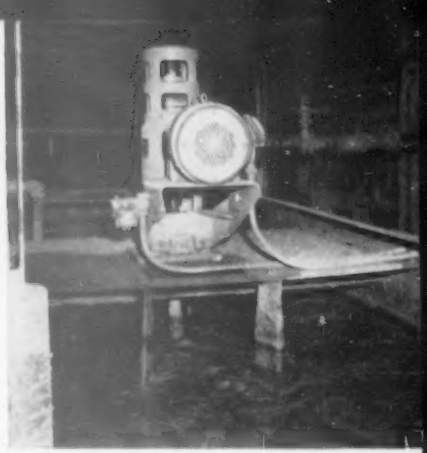

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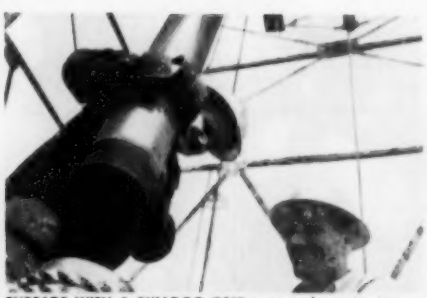

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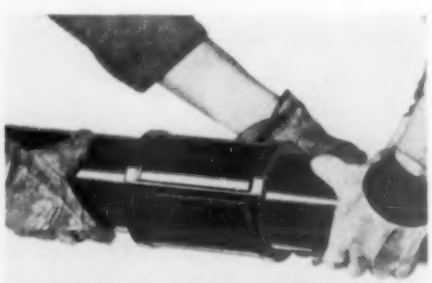

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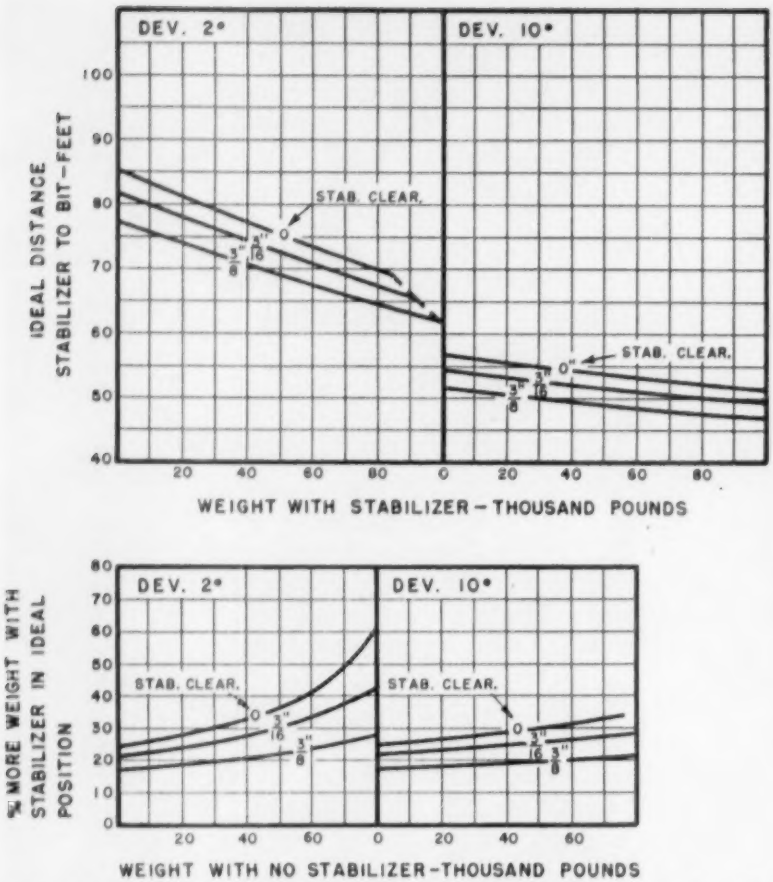

Fig. 2—Influence of stabilizer clearance. For this packed-hole case, the hole size is 8¾ in., and the collars are 8 in.

is displaced downward by an increase of weight.

2. The ideal position of a stabilizer is, in most cases, displaced downward by an increase of hole inclination. As an example, assume we are drilling an 8¾-in. hole with 6-in. drill collars and 10,000 lb. on bit. Then, Point I, Fig. 11, shows that for an inclination of 2°, the ideal position of the stabilizer is 93 ft. above the bit. Point J, Fig. 11, shows that for an inclination of 3°, the ideal position is 85 ft. above.

3. For some conditions the previous conclusion does not hold true, and the ideal position is independent of hole angle. As an example, assume we are drilling an 8¾-in. hole with 6-in. drill collars and 40,000 lb. on bit. Point H, Fig. 11, shows that for an inclination of 2°, the ideal position of the stabilizer is 56 ft. above the bit. Point H (same point) also shows that the ideal position is still 56 ft. for an inclination of 3°.

Influence of Clearance on Benefit From Using a Stabilizer

So far, we have analyzed situations in which the stabilizer completely fills the hole. We will now investigate the influence of stabilizer clearance.

The lower charts of Figs. 2 and 3 show how clearance affects the percentage improvement. They are representative of packed hole and nonpacked hole conditions respectively. For both figures, the left-hand and right-hand charts are for hole deviations of 2° and 10°, respectively.

Inspecting the charts leads to these conclusions:

1. As clearance increases, the percentage improvement decreases.

2. The loss in percentage improvement for the same clearance is much greater for packed holes than nonpacked holes.

For example, take the case of 8-in. collars in 8¾-in. hole. With light weight, about one-third of the percentage improvement is lost when clearance increases from zero to ⅜ in. The loss is greater than one-third for heavy weight.

Then, consider 6-in. collars in 8¾-in. hole, with both light and heavy weight. In either case only about one-tenth of the percentage improvement is lost when clearance increases from zero to ⅜ in.

Influence of Clearance on Ideal Position of Stabilizer

The upper charts of Figs. 2 and 3 illustrate how clearance affects the ideal stabilizer position. These charts show that:

1. In packed holes, as clearance increases, the ideal stabilizer position is displaced downward.

2. In nonpacked holes, this effect is much less pronounced and even nil for heavy weight.

Practical Position of Stabilizer

In actual drilling it would be very impractical to keep displacing the stabilizer as the ideal position varies. Therefore, let us find how much is lost by placing the stabilizer away from the ideal position.

Fig. 4 shows how placing the stabilizer 10 per cent off the ideal position affects the percentage improvement. It covers examples for:

1. Packed holes (8-in. collars, 8¾-in. hole) and nonpacked holes (6-in. collars, 8¾-in. hole).

2. Small and large stabilizer clearances (zero clearance and ⅜ in.).

3. Small and large hole inclinations (2° and 10°).

Three curves are drawn in each diagram, namely:

(a) Curve I for the stabilizer at the ideal position.

(b) Curve L for the stabilizer 10 per cent too low.

(c) Curve H for the stabilizer 10 per cent too high.

The diagrams lead to these conclusions:

1. If the stabilizer is located 10 per cent off the ideal position, either too low or too high, then, for light weight, over half of the percentage improvement is lost.

2. As the weight increases, it becomes progressively better to place the stabilizer too low rather than too high.

3. In nonpacked holes, this is extremely significant in a frequently used range of weights.

4. In packed holes, it is significant for very heavy weights only.

As a general rule . . . From a combination of information such as that presented in Figs. 2, 3, and 4, one could establish a practical range of stabilizer locations rather than the ideal location only. However, such work is confusing and not very practical. After having worked many numerical examples, it was found that the following general rule, although far from perfect, may be used because of its simplicity.

"Place the stabilizer between the ideal position, according to Figs. 5 to 20,

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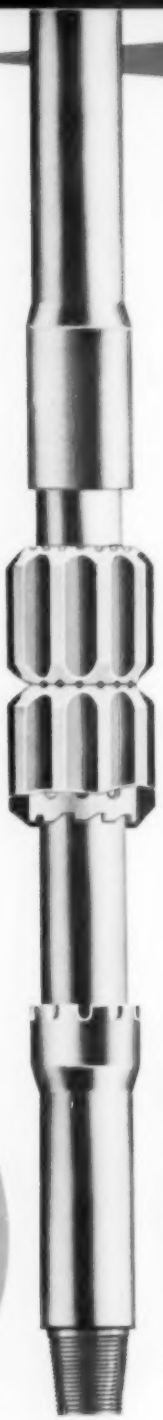

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and a position 10 per cent closer to the bit."

This makes allowance for the following:

1. In packed holes, stabilizer clearance appreciably lowers the ideal stabilizer position. There is bound to be some clearance either because the hole is oversized or because the stabilizer is worn.

2. In nonpacked holes, clearance has some effect although less than in packed holes. Much of the drilling in nonpacked holes may be in a weight range where it is much worse to have the stabilizer too far than too close.

3. There is always a section of reduced diameter at the stabilizer. This lowers the ideal stabilizer position. (Any reduction of diameter in a drill-collar string decreases its quality as a straight-hole tool. Both the diameter reduction and the length of the reduced section should be kept to a minimum.)

The above rule does not allow for this fact: with very light weight in nonpacked holes, where effect of clearance is minor, most of the indicated improvement is lost if the stabilizer is placed 10 per cent too close to the bit. Under such conditions, it might be desirable to put the stabilizer no more than 5 per cent closer than the ideal position indicated by Figs. 5 to 20.

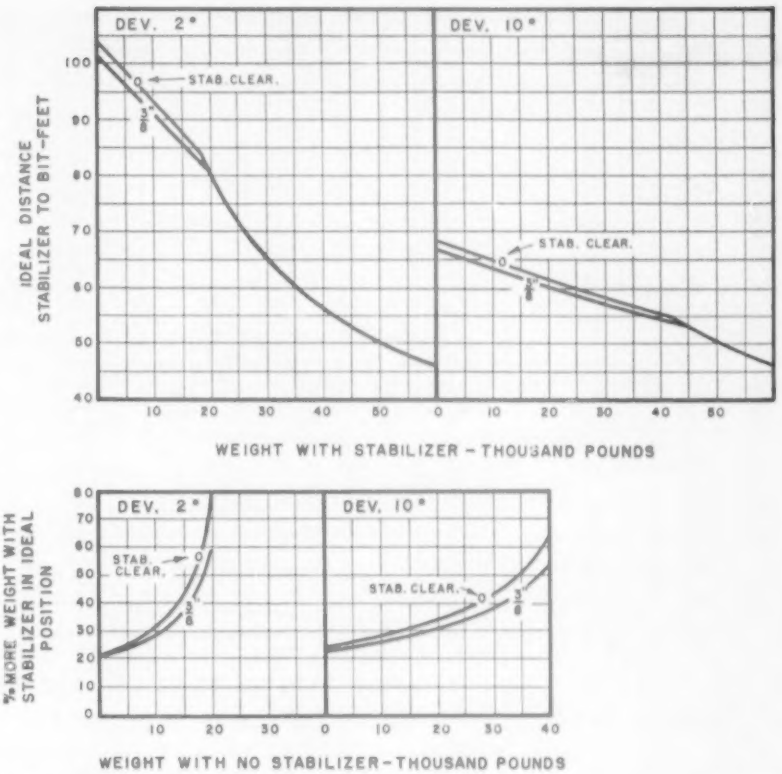
DEV. 2°
DEV. 10°
STAB. CLEAR.
IDEAL DISTANCE STABILIZER TO BIT-FEET
WEIGHT WITH STABILIZER - THOUSAND POUNDS
% MORE WEIGHT WITH STABILIZER IN IDEAL POSITION
WEIGHT WITH NO STABILIZER - THOUSAND POUNDS

Fig. 3—Influence of stabilizer clearance. This is an example of a nonpacked hole—hole size is 8¾ in. and collars are 6 in.

How much improvement . . . The magnitudes of some of the factors affecting the ideal position of the stabilizer are not known. Therefore, it is impossible to state exactly how much improvement may be expected if the above recommendations are followed. The authors estimate that the weight could be increased by about 20 per cent in very crooked formations and 50 per cent in mildly crooked formations.

The weight increase of 20 per cent obtainable in very crooked formations should not be minimized. Even though it may amount to an increase in weight of only 1,000 or 2,000 lb., it should always result in an increase in drilling rate of at least 20 per cent with some increase in bit footage.

The conclusions reached above have been partly confirmed by field experience as follows:

1. Use of stabilizers in very crooked formations (light weight) has often resulted in no improvement. This is understandable since the maximum possible benefit is rather limited. Moreover, such benefit depends rather critically on properly locating the stabilizer. It is believed that proper application of this paper would lead to noticeable results.

2. Use of stabilizers in mildly crooked formations (heavy weight) has been successful.[6,7] This is also understandable. Under these conditions the benefits which may be gained by a stabilizer are large, and its proper positioning is not very critical. It is believed that proper application of the findings of this paper would consistently lead to still better results.

Changing the position . . . In actual drilling, hole deviation and weight change as drilling progresses. Therefore, the ideal position of the stabilizer also changes, and subs must be used to displace the stabilizer as needed. Consideration of several situations led to these general conclusions:

1. When drilling with a nearly constant deviation (in the vicinity of the contract angle), two subs on the rig are enough. Only one of these is used at a time to keep the stabilizer within the recommended range.

2. When, in order to decrease drilling costs, the contract permits a gradual buildup of angle, say 1° per 1,000 ft., then three or four subs may be needed on the rig. Again, only one of them is used at a time.

As an example assume an 8¾-in. hole is to be drilled with 8-in. drill collars and a stabilizer. The contract angle is 5°, but an attempt will be made to keep the angle within 4°. Previous experience indicates that weight will vary between 10,000 and 40,000 lb.

Fig. 10 indicates that for a 4° hole and 8-in. collars, the ideal stabilizer position is 70 ft. for 10,000 lb. and 67 ft. for 40,000 lb. One sub, positioning the stabilizer at 67 ft. from the bit, would suffice because, for both weights, the stabilizer would be located within the recommended range.

Use of More Than One Stabilizer

So far we have analyzed the effect of stabilizing the string at one point. Consider now the effect of a continuous stabilization.

Continuous stabilization has been tried in the past, for instance by welding long strips on the drill collars. In the case of continuous stabilization, the equilibrium angle may be calculated with our previous studies.[4,5] This is done simply by considering as hole clearance the diametral clearance between hole and strips and not between hole and collars. Thus it may be shown that, in crooked formations, such a small clearance results in a larger equilibrium angle than with one stabilizer at the ideal position.

This, however, does not necessarily mean that continuous stabilization is always detrimental. Such a stabilization results in less severe dog-legs and in a much smaller rate of buildup angle. Therefore continuous stabilization could be useful in the following two cases:

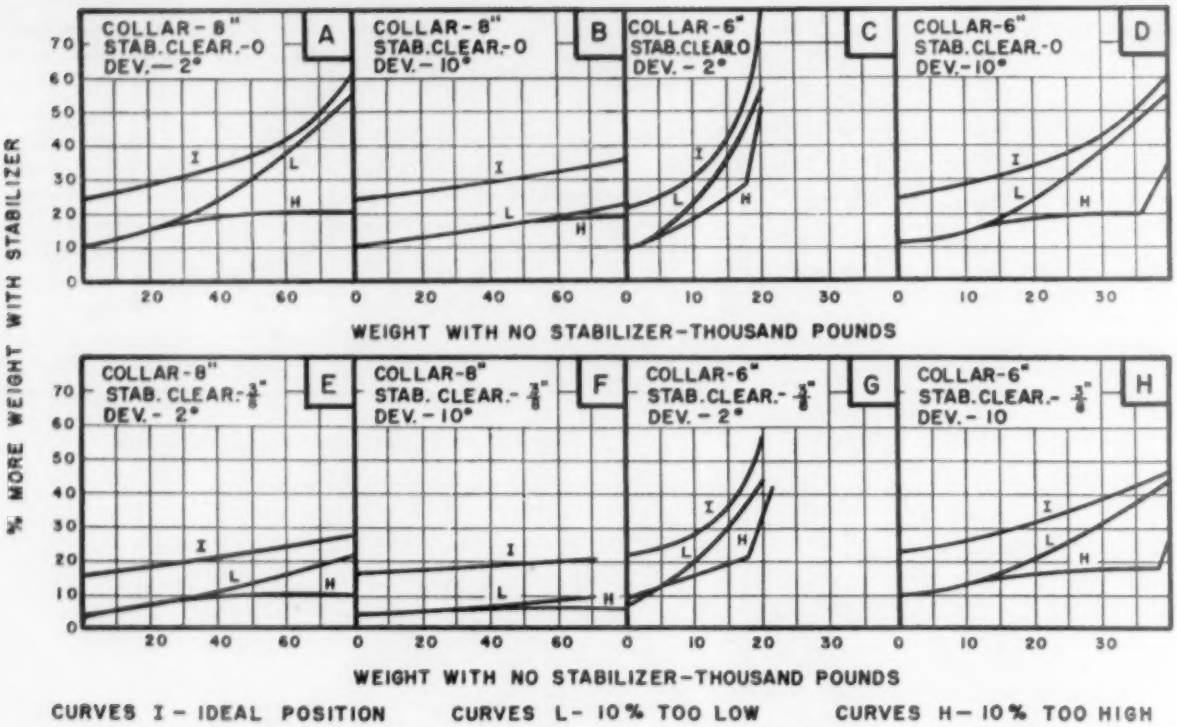

Fig. 4—Influence of stabilizer located off ideal position. Hole size is 8¾ in.

1. Drilling short sections of extremely crooked-hole formations. Continuous stabilization would result in an equilibrium angle that is all out of reason if the section were thick enough. However, the rate of buildup of angle may be so low that the section is drilled through before the angle becomes excessive.

2. Drilling when building up angle until the maximum acceptable angle is reached. The slow rate of buildup of angle permits one to carry more weight. After the maximum acceptable angle is reached, complete stabilization becomes detrimental. Then drilling should proceed either without any stabilization or with a stabilizer close to the ideal position.

More than one stabilizer . . . Our interest in continuous stabilization stems from the use of several closely spaced stabilizers in the lower portion of the string, with the lowermost just above the bit. This arrangement results in a condition approaching continuous stabilization, and the statements in the section above approximately hold true.

If more than one stabilizer is used and the lowermost is at ideal position, then we believe that the additional stabilizers have little, if any, effect on hole deviation. Some express the opinion that they decrease over-all stabilizer wear and reduce frequency of drill-collar connection failures.[7,8] The analysis of this possibility is outside the scope of this paper.

Use of Reamers

A reamer above the bit is commonly used when drilling through certain abrasive formations in the Permian basin. The effect of a reamer was not mathematically investigated, but we believe that its presence greatly increases the equilibrium angle. Possibly using a stabilizer 30 ft. above the reamer reduces part of its detrimental effect.

As in the case of continuous stabilization previously analyzed, the combination of a reamer and stabilizer may be useful in reducing the rate of build-up angle.

Editor's note: The authors' original paper contained a group of dimensionless charts which are the basis for Figs. 5 to 20. The charts can also be used to make dimensional charts for any other hole and drill-collar sizes. The original paper also included a mathematical appendix showing the derivation of formulas on which the charts are based. Both the dimensionless charts and the mathematical appendix are available through the authors.

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FIGS. 5-20

The 16 charts on the following 8 pages are for the use of one stabilizer in several popular hole sizes. For other hole sizes, charts may be made from a group of dimensionless charts available from the authors.

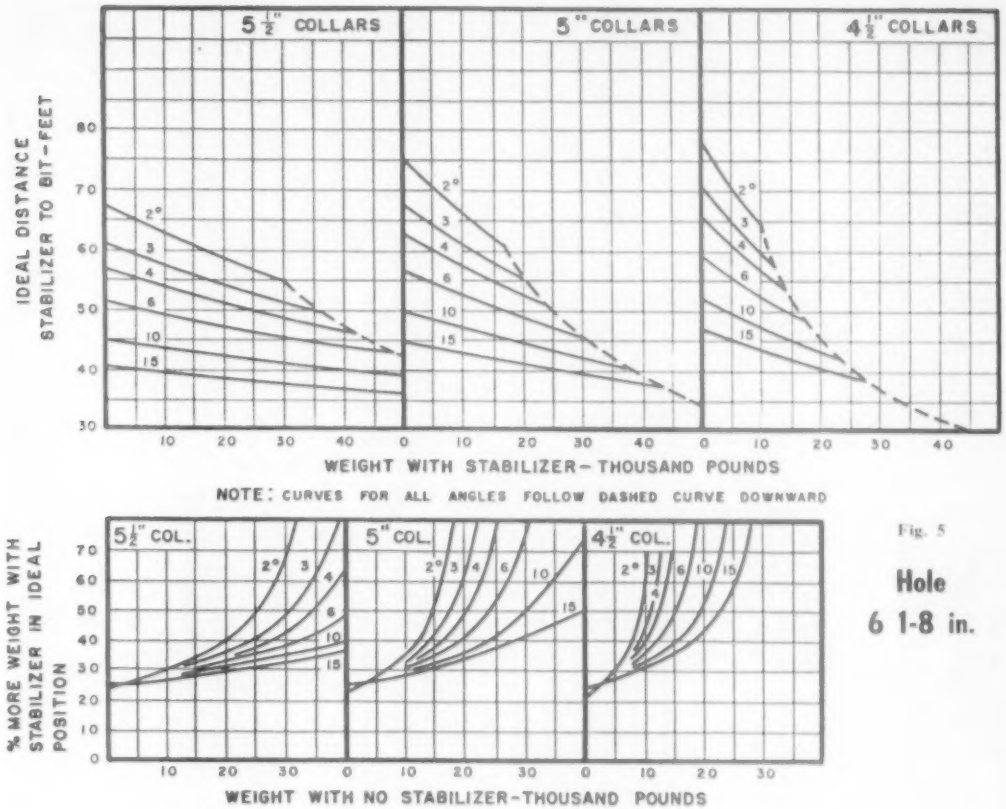


Fig. 5

Hole
6 1-8 in.

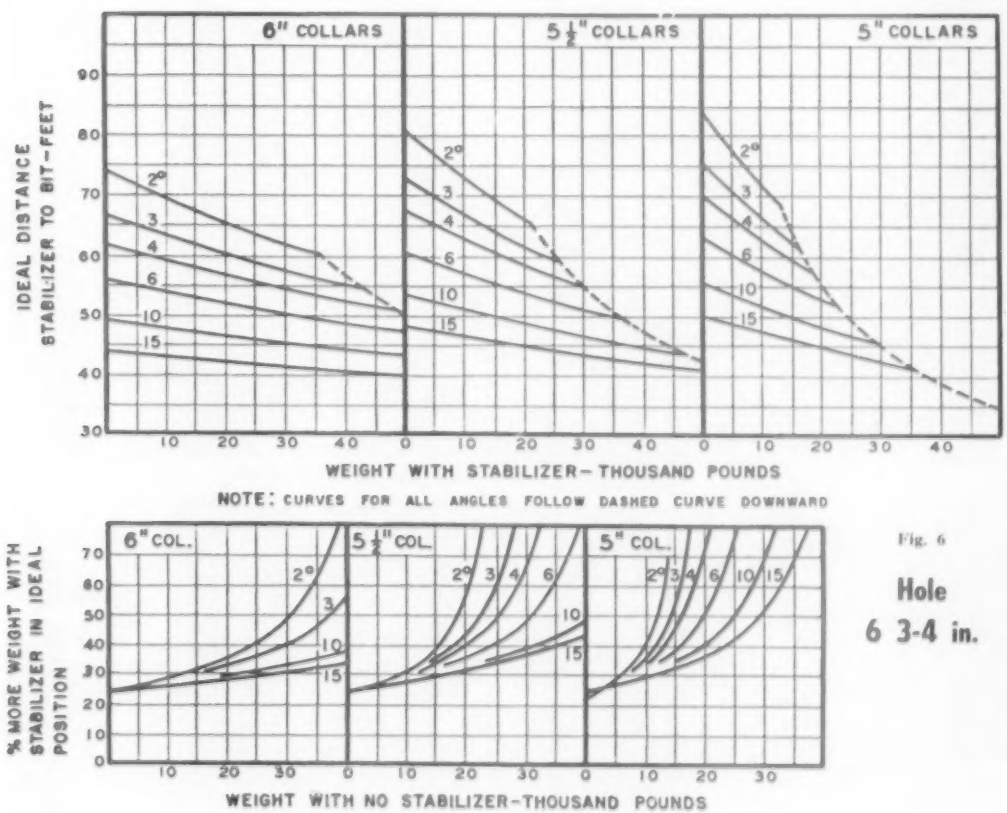
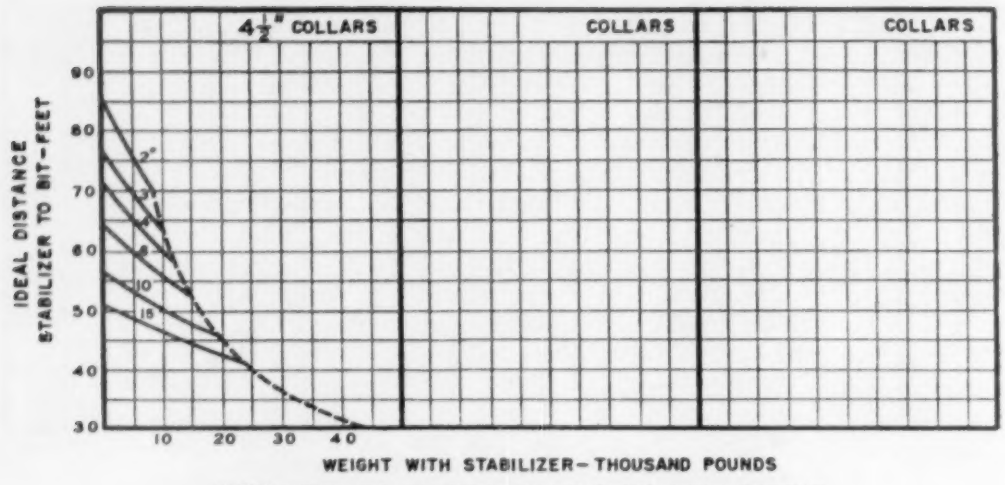


Fig. 6

Hole
6 3-4 in.



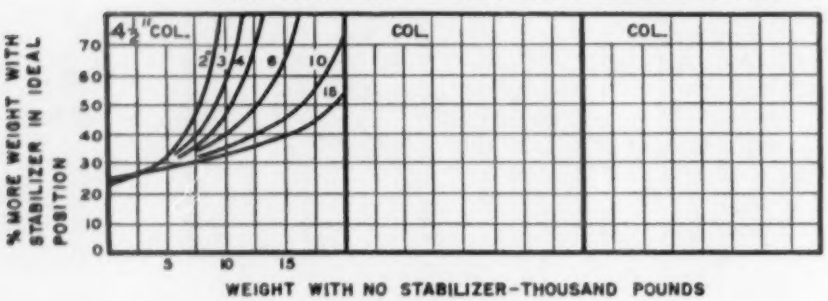
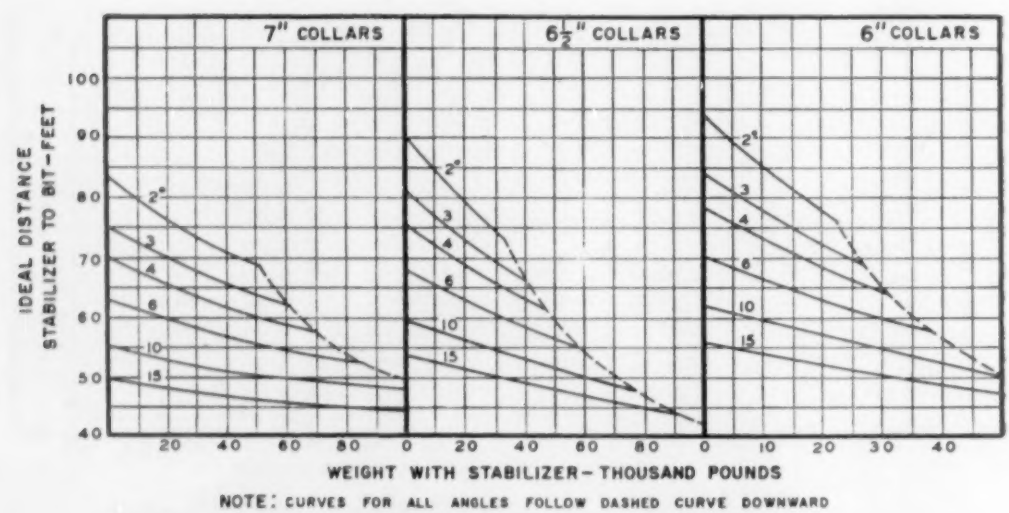


Fig. 7

Hole
6 3-4 in.


7" COLLARS
6½" COLLARS
6" COLLARS
IDEAL DISTANCE STABILIZER TO BIT-FEET
WEIGHT WITH STABILIZER-THOUSAND POUNDS
NOTE: CURVES FOR ALL ANGLES FOLLOW DASHED CURVE DOWNWARD

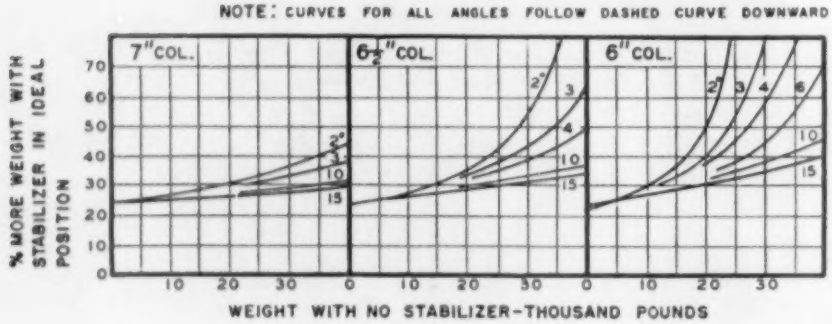
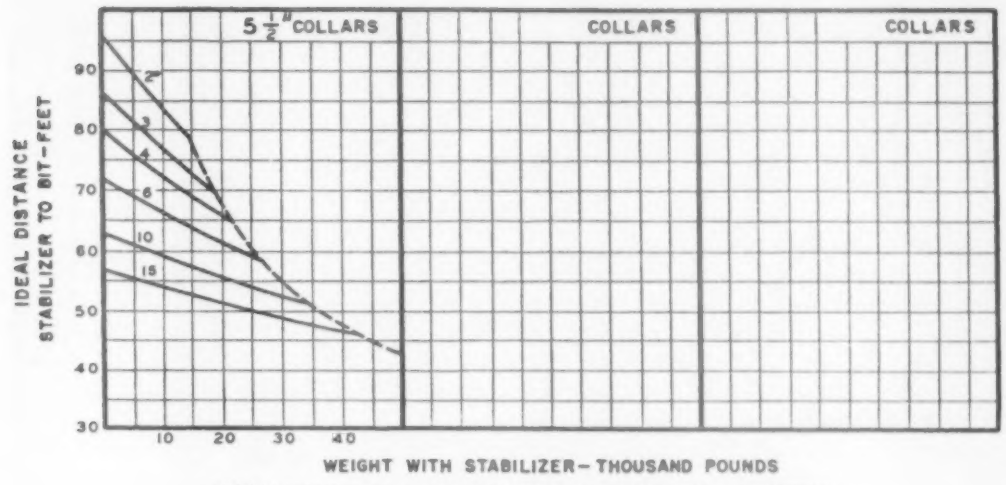


Fig. 8

Hole
7 7-8 in.



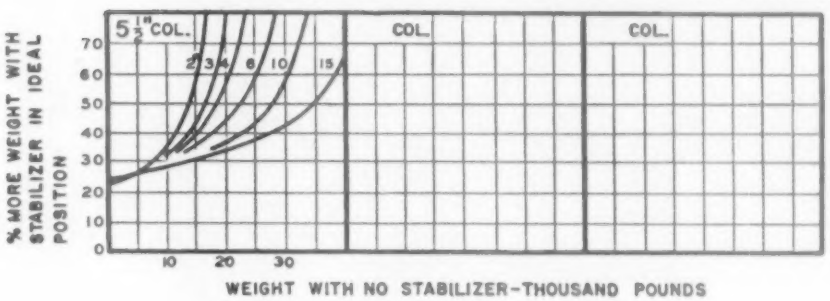
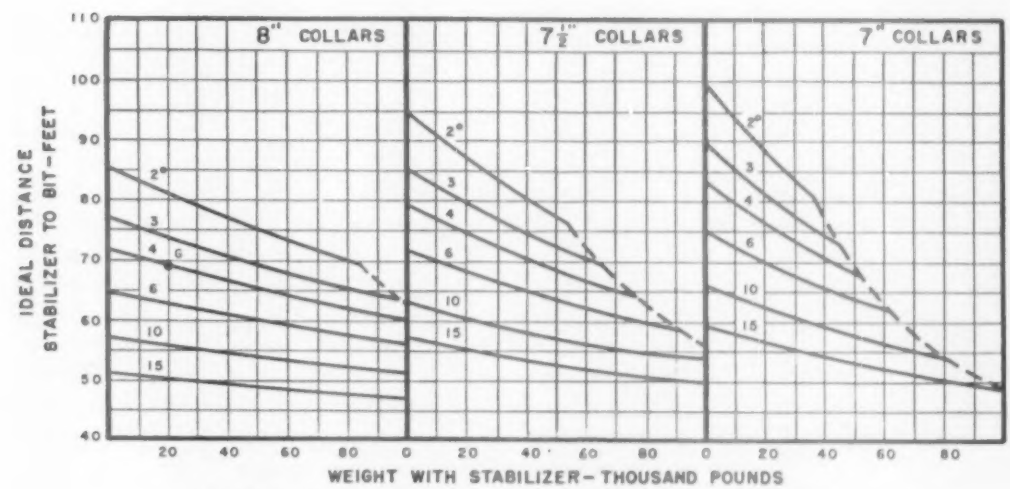


Fig. 9

Hole 7 7-8 in.



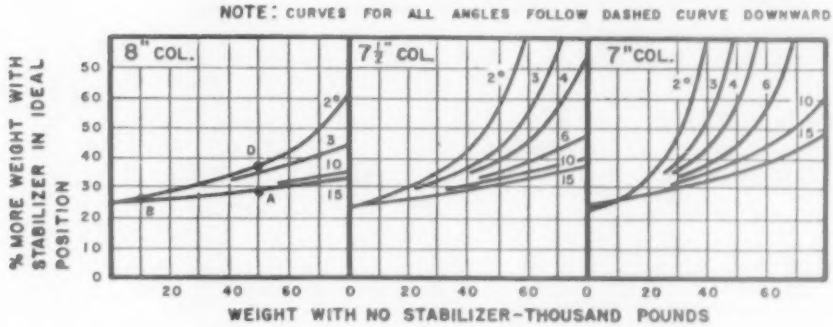


Fig. 10

Hole 8 3-4 in.

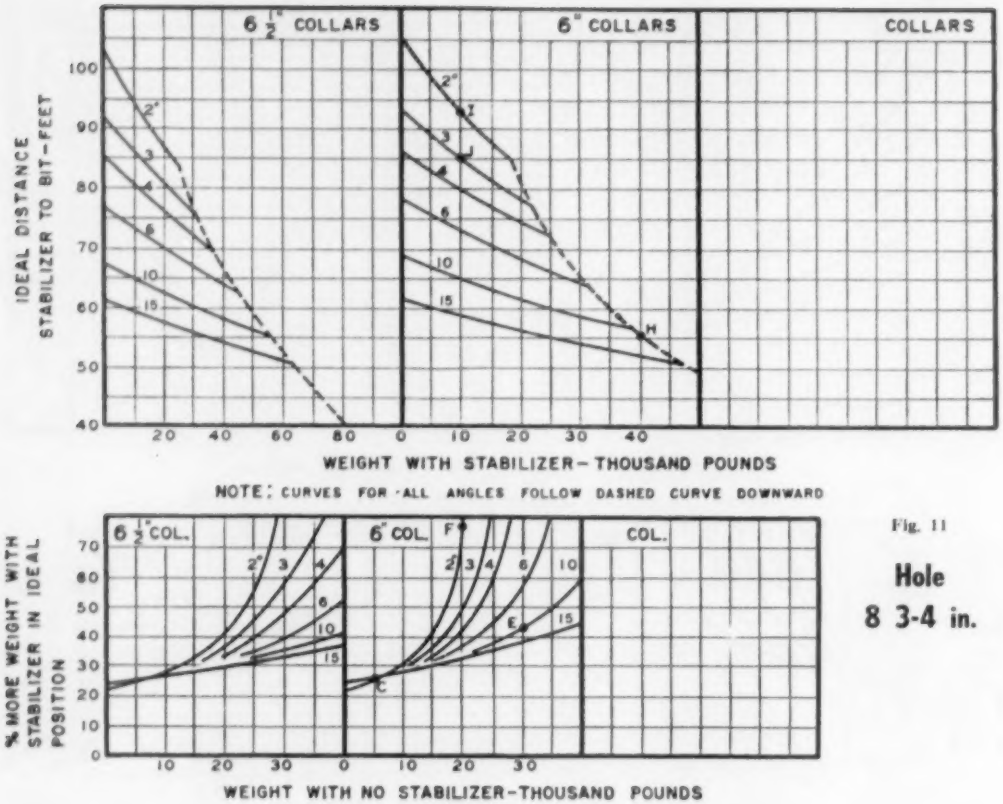


Fig. 11

Hole 8 3-4 in.

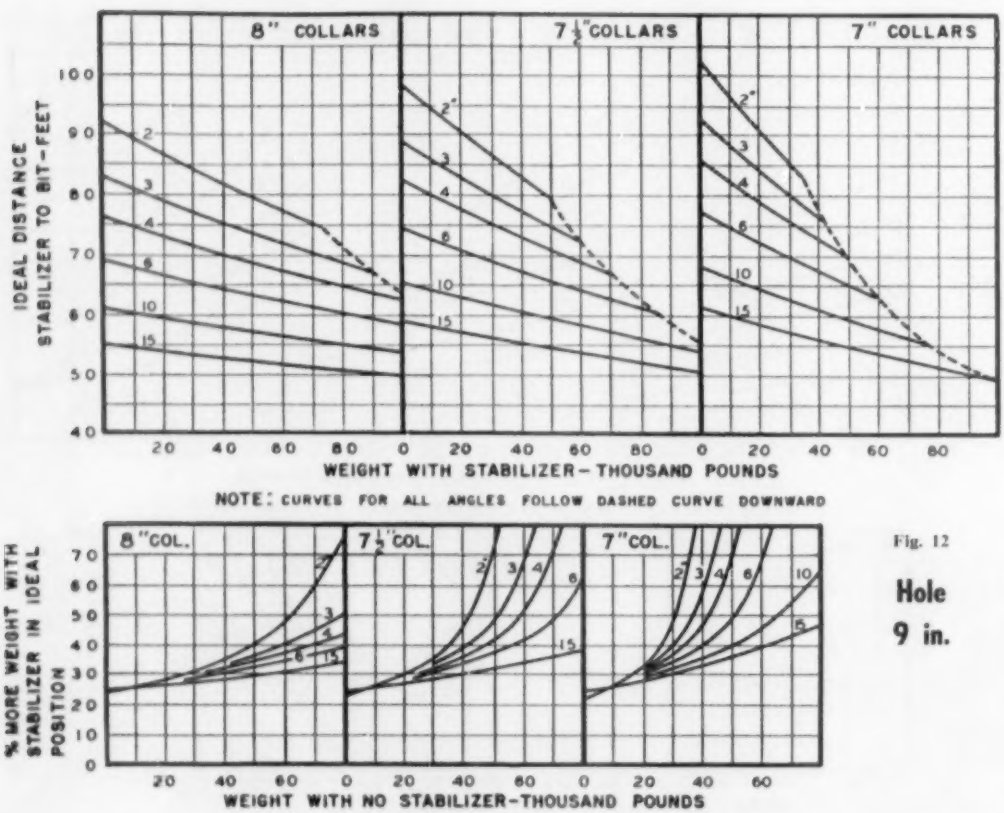
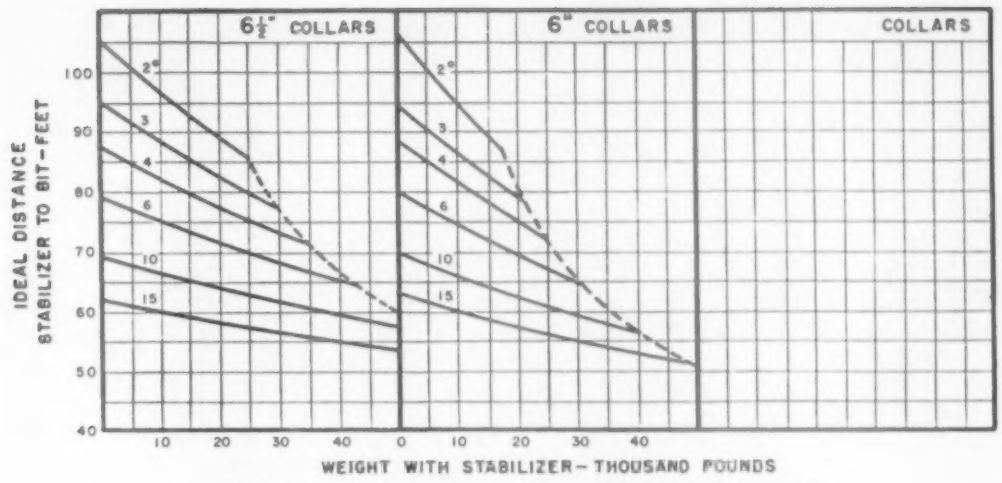

8" COLLARS
7 1/2" COLLARS
7" COLLARS
IDEAL DISTANCE STABILIZER TO BIT-FEET
WEIGHT WITH STABILIZER-THOUSAND POUNDS
NOTE: CURVES FOR ALL ANGLES FOLLOW DASHED CURVE DOWNWARD
8" COL.
7 1/2" COL.
7" COL.
% MORE WEIGHT WITH STABILIZER IN IDEAL POSITION
WEIGHT WITH NO STABILIZER-THOUSAND POUNDS

Fig. 12

Hole 9 in.



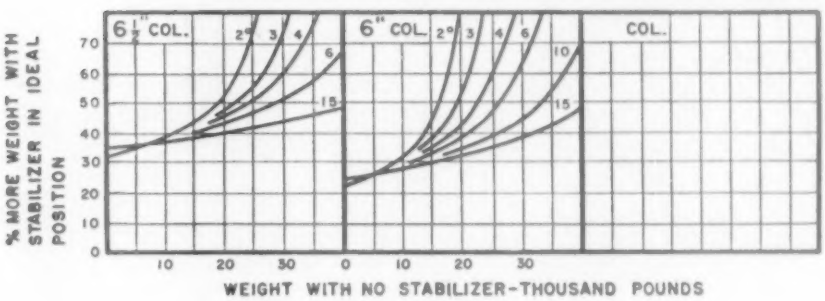
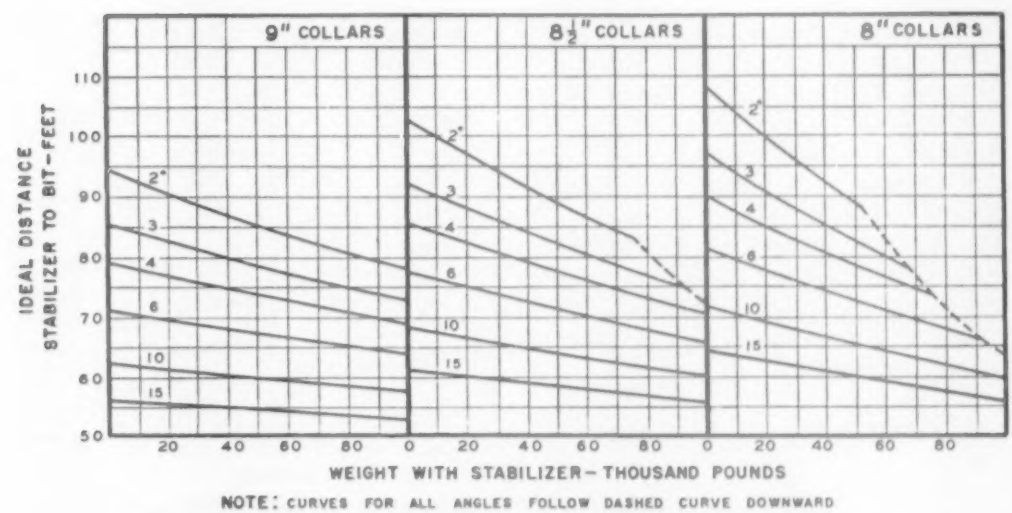


Fig. 13

Hole 9 in.


9" COLLARS
8½" COLLARS
8" COLLARS
IDEAL DISTANCE STABILIZER TO BIT-FEET
WEIGHT WITH STABILIZER-THOUSAND POUNDS
NOTE: CURVES FOR ALL ANGLES FOLLOW DASHED CURVE DOWNWARD

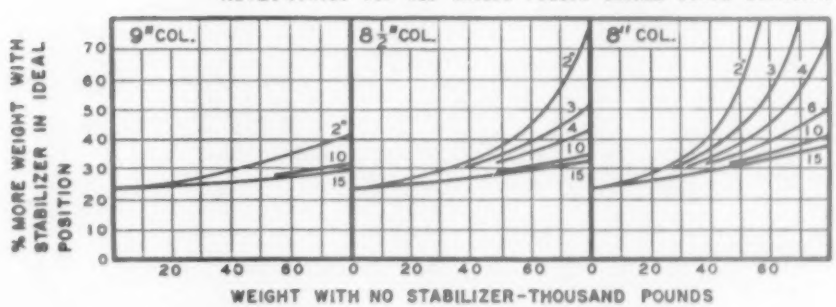


Fig. 14

Hole 9 7-8 in.

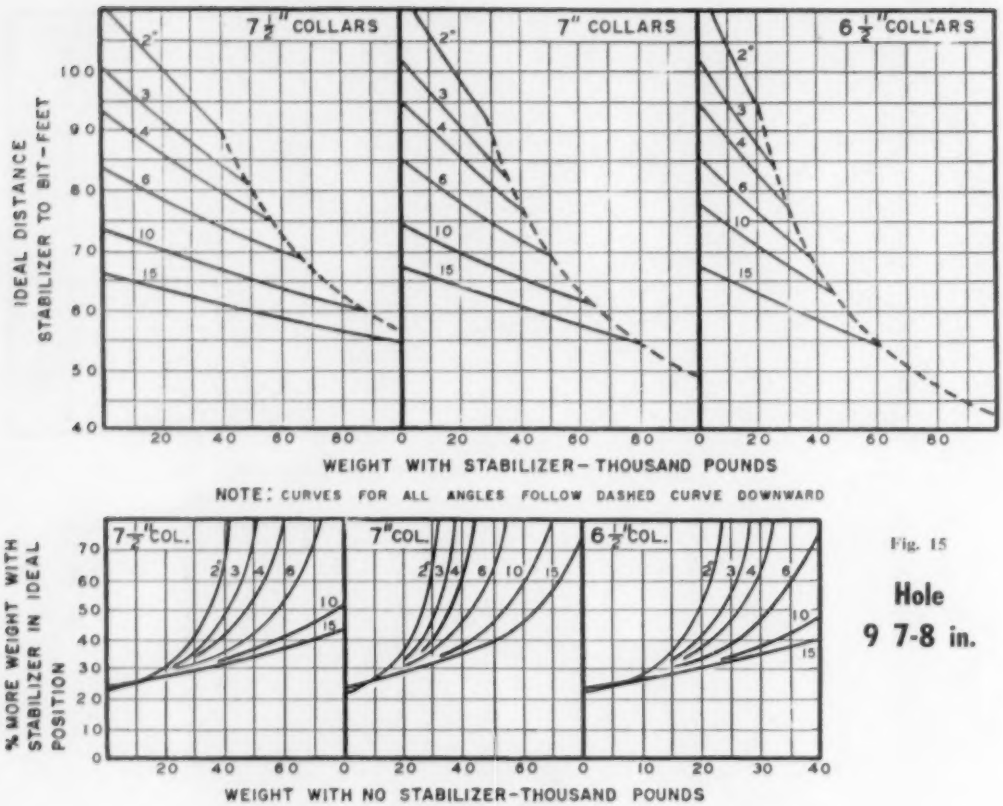


Fig. 15

Hole
9 7-8 in.

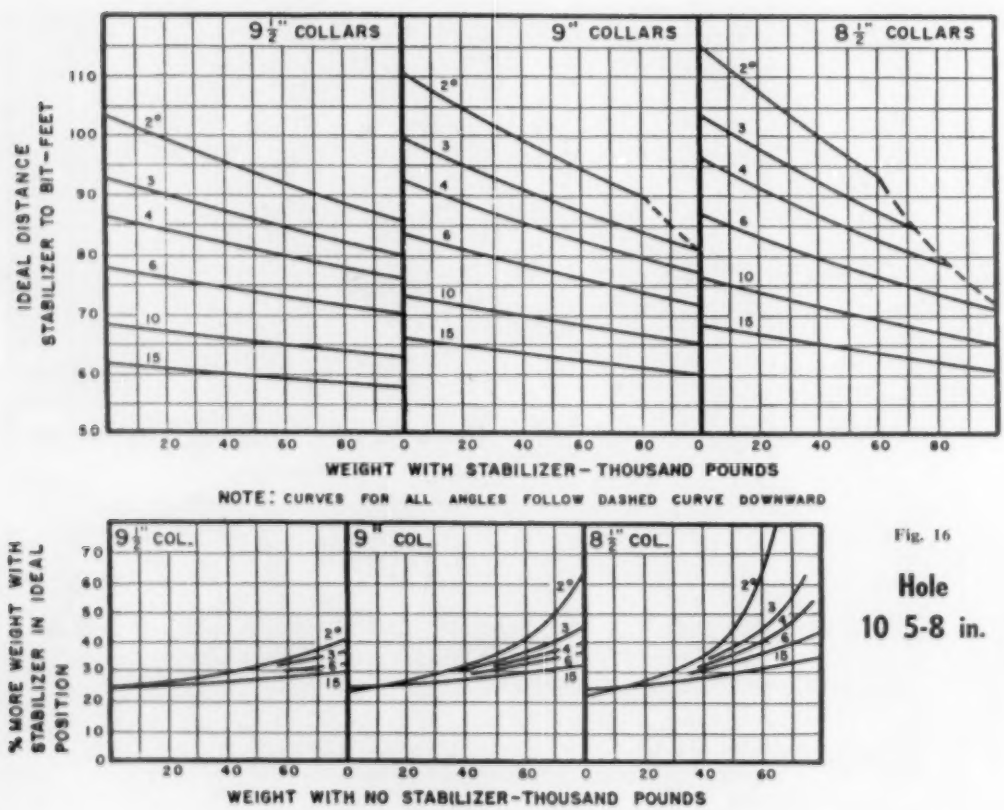
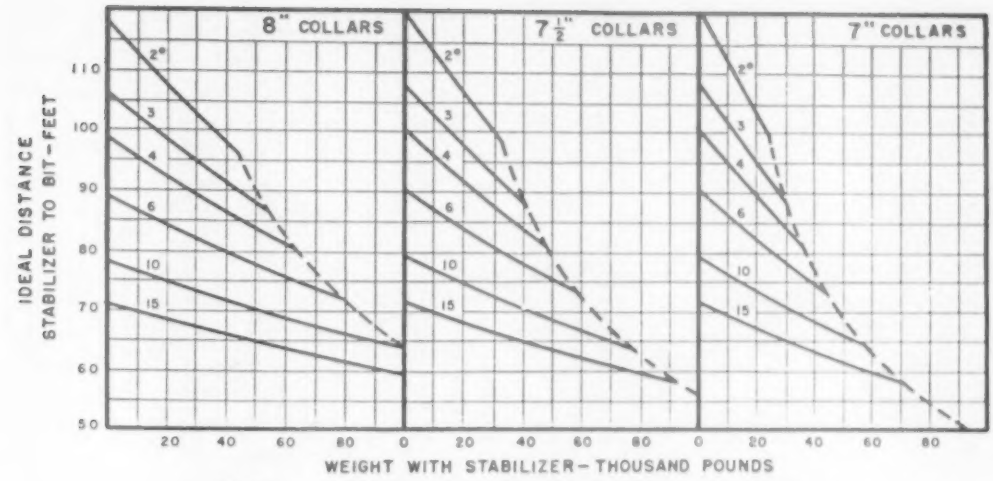


Fig. 16

Hole
10 5-8 in.


8" COLLARS
7 1/2" COLLARS
7" COLLARS
IDEAL DISTANCE STABILIZER TO BIT-FEET
WEIGHT WITH STABILIZER-THOUSAND POUNDS
NOTE: CURVES FOR ALL ANGLES FOLLOW DASHED CURVE DOWNWARD

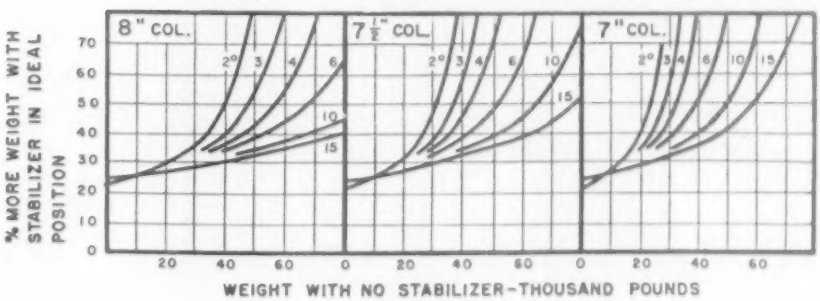
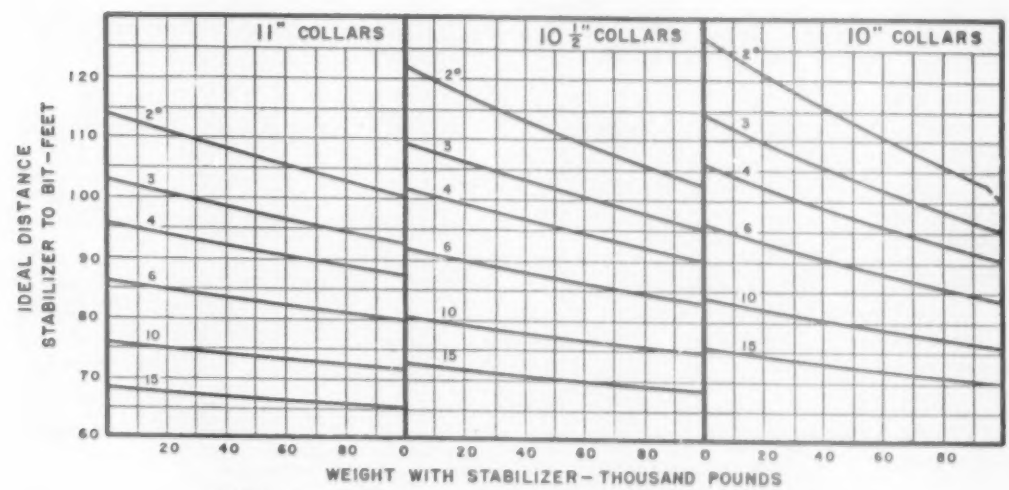


Fig. 17

Hole 10 5-8 in.


11" COLLARS
10 1/2" COLLARS
10" COLLARS
IDEAL DISTANCE STABILIZER TO BIT-FEET
WEIGHT WITH STABILIZER-THOUSAND POUNDS
NOTE: CURVES FOR ALL ANGLES FOLLOW DASHED CURVE DOWNWARD

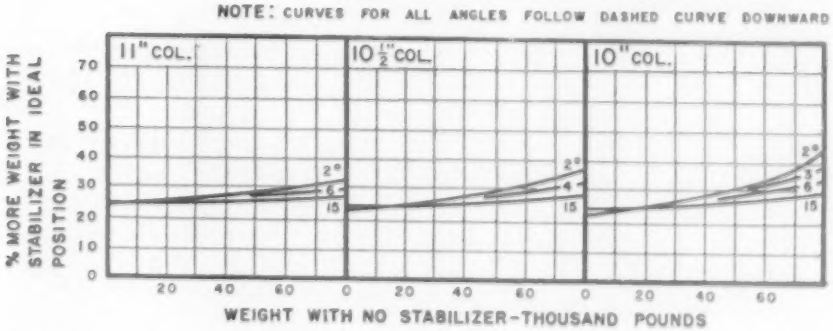
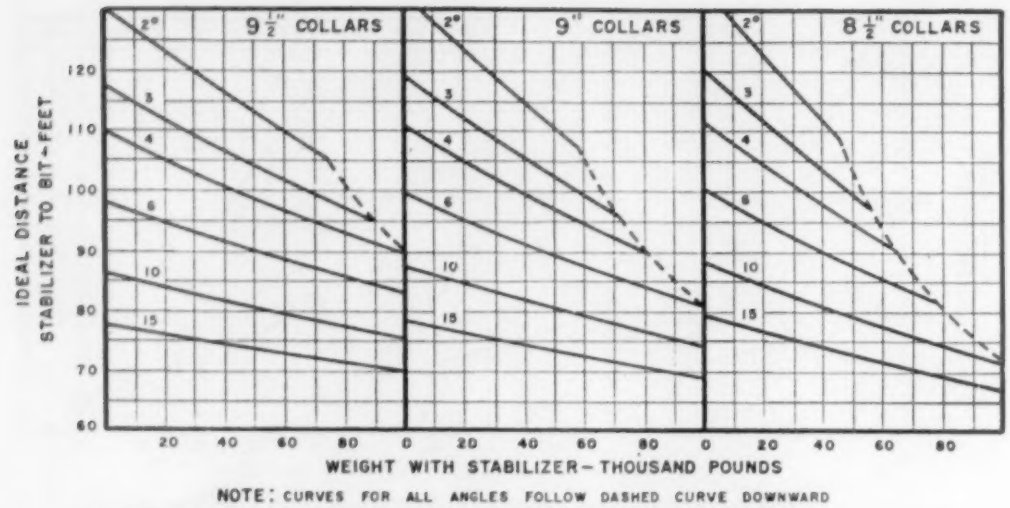


Fig. 18

Hole 12 1-2 in.



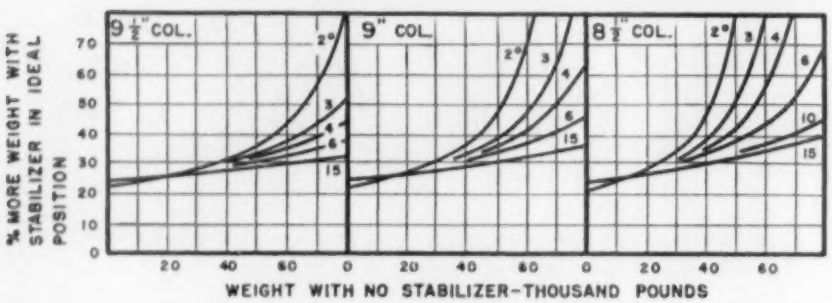
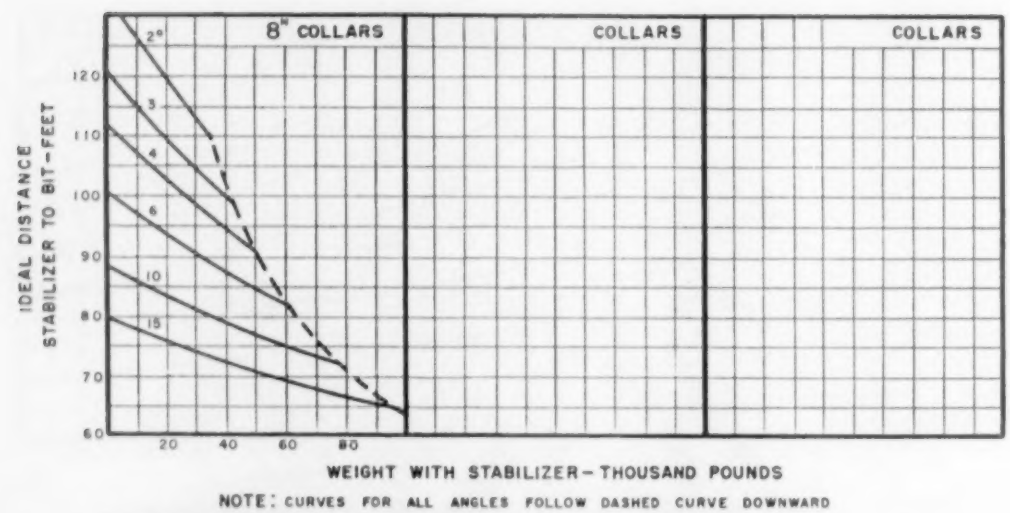


Fig. 19

Hole
12 1-4 in.



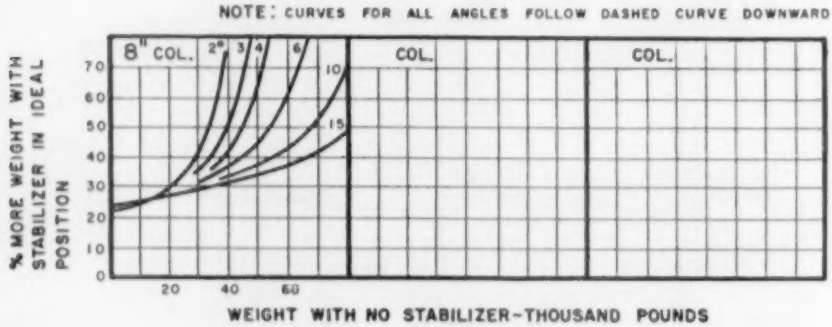


Fig. 20

Hole
12 1-4 in.

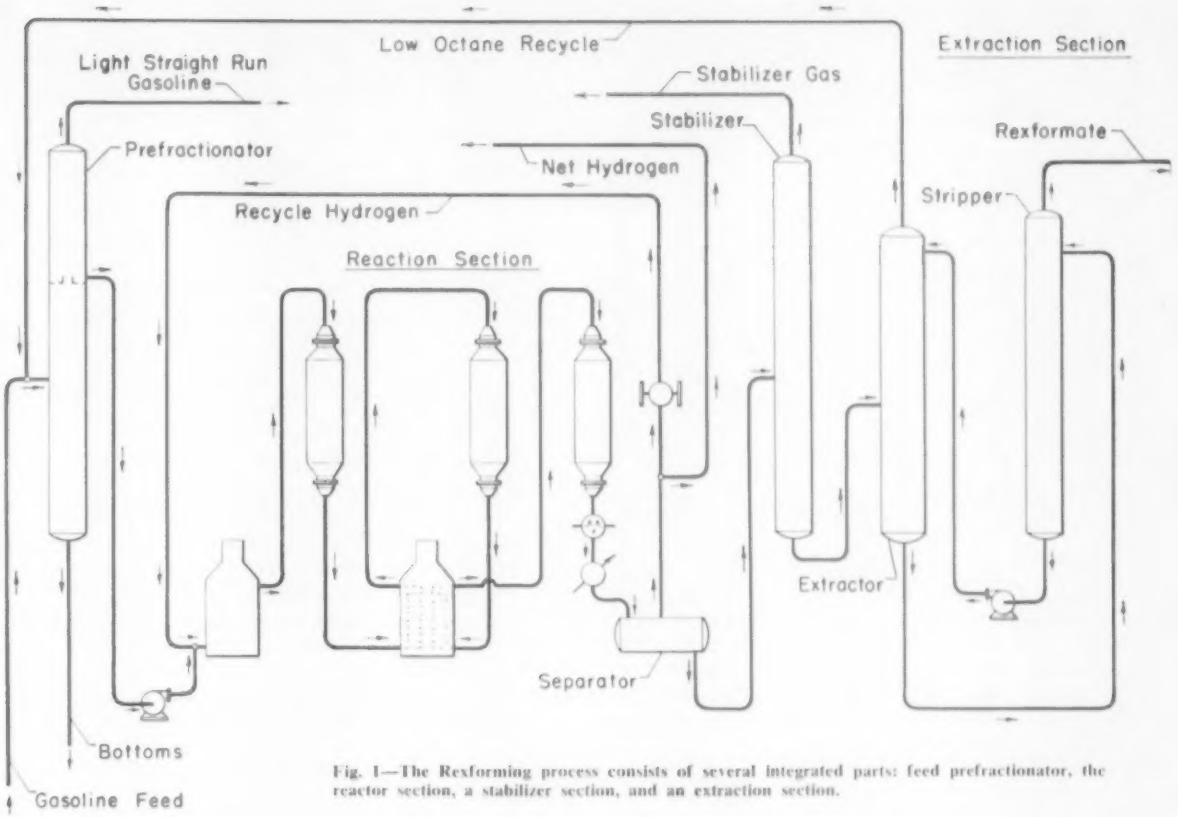


Fig. 1—The Rexforming process consists of several integrated parts: feed prefractionator, the reactor section, a stabilizer section, and an extraction section.

Rexforming—Its Product Will Meet Any Motor-Fuel Needs Now in Sight

U.O.P. has pioneered other processes

THE refining industry has been deeply concerned with recent trends in both the automotive and refining fields which give rise to predictions of unprecedented increases in gasoline quality in the near future. In recognition of these trends U.O.P. has directed research efforts toward the development of a practical method for the production of such "super quality" gasolines.

The trend of octane ratings of marketed gasoline has been steadily upward, and a parallel trend is shown in octane requirements of automobile engines. Each year shows engines having higher compression ratios and higher power outputs, requiring fuels of increasing quality to maintain satisfactory antiknock performance.

The U.O.P. Platforming process—the first catalytic reforming process to be applied widely in both large and small refineries—was announced in 1949. The extensive adoption of Platforming, pioneering the use of platinum catalysts for reforming, demonstrated that this process fills a real need of refiners all over world.

The production of aromatic hydrocarbons by dehydrogenation of naphthenes and by dehydrocyclization of paraffins is an important part of the chemistry of Platforming. The demand for aromatics of high purity indicated a profitable alternate Platforming operation, if the aromatics could be economically separated at high purity.

The Udex process, utilizing new solvent-extraction techniques, was developed for this purpose. Wide boiling mixtures are processed, allowing simple distillation of the recovered aromatics for the production of nitration-grade benzene, toluene, and mixed xylenes. The combined use of the Platforming and Udex processes permits the oil industry to produce large volumes of pure aromatics.

With the widespread adoption of catalytic reforming, it became important to develop means for handling marginal feed stocks, which due to their sulfur, nitrogen, olefin, and metals contents would be unsuitable for catalytic reforming. One year ago the solution to this problem, through application of the Unifining process, was announced to the industry.

We now offer the petroleum industry a new refining tool, Rexforming, which will permit the production of fuels of any useful octane rating, without limitation due to feed stock.

by

H. W. Grote, V. Haensel, and M. J. Sterba

REXFORMING is a new process for the production of fuels which will satisfy the octane requirments of the most demanding cars now under development by the automobile industry.

Super-quality fuels are produced by mild catalytic reforming of a full-range gasoline stock and removing low-octane material in the reactor effluent by solvent extraction. The low-octane components are recycled to the reactor.

Finished Rexformate is a water-white gasoline of controlled volatility characteristics. Due to the mild process conditions employed, side reactions are minimized, catalyst life is extended, and over-all yields are good.

The recycle nature of the process

Authors are with Universal Oil Products Co., Des Plains, Ill. Paper presented at W. P. R.A. meeting, March 29, 1955, San Antonio.

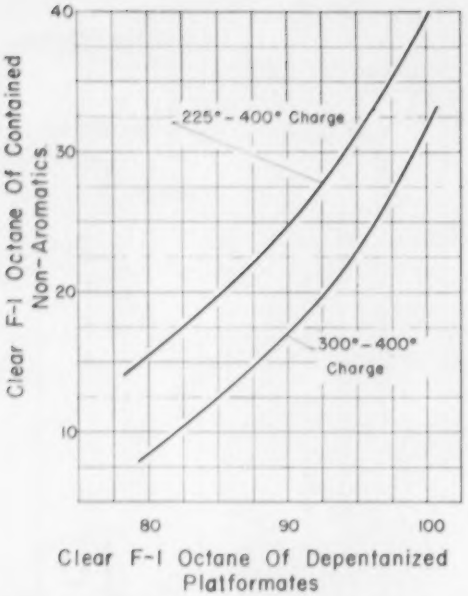


Fig. 2—Octane ratings of nonaromatics from Platformates.

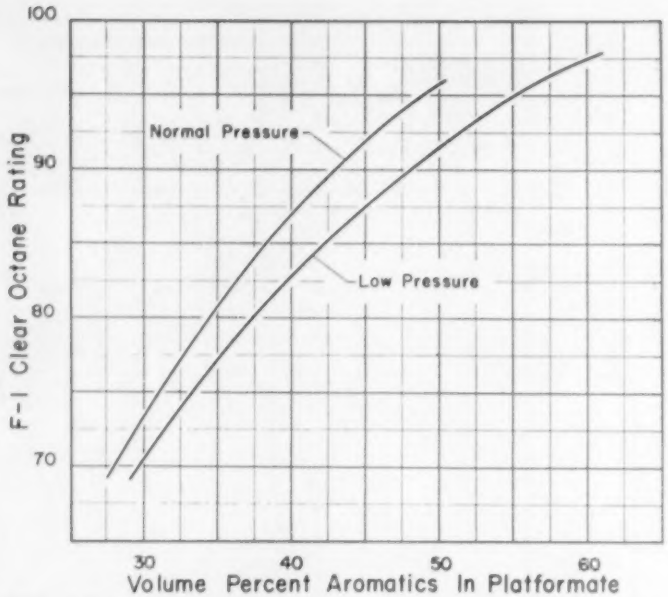


Fig. 3—Effect of operating pressure on aromatic contents of Platformates from Fischer-Tropsch naphtha.

gives refiners an additional process variable. Low-naphthene feeds can be processed as conveniently as stocks containing relatively high naphthene concentrations.

A Rexforming unit operates at high space velocities, and catalyst requirements are about the same as those needed for single-pass operations at much lower severities. Units can be installed utilizing equipment from existing Platformers. For the same fresh-feed rate, no additional catalyst is required, some additional heat-exchange equipment must be added, and a suitable solvent-extraction section is required.

A typical Rexforming installation will cost about $300 per barrel of daily capacity to build and about 36 cents to operate, excluding royalty, depreciation, administration, and overhead costs.

Description of Process

The Rexforming process consists of several integrated parts: feed prefractionator, the reaction section, a stabilizer section, a stabilizer and an extraction section (Fig. 1).

When processing a full-boiling-range gasoline, the charging stock is fed to a reboiled prefractionator which removes overhead a light gasoline fraction. The side cut from this column is the combined feed to the reaction section. The flow through the reactors which contain the Platforming catalyst, and through the heaters is simlar to that of a Platforming unit. The reactor effluent, after cooling, passes to a separator, from which a hydrogen-rich gas is circulated to the reactors. The net vent hydrogen is also removed from this separator.

Extraction . . . The separator liquid is fed to a stabilizer which in this case serves as a debutanizer. The stabilized material is charged to an extraction column, which continuously rejects from the top of the column the low-octane-number components. This rejected stream is returned to mix with fresh feed, achieving selective conversion of low-octane heavy paraffins to high-octane components.

The separation in the extractor is selective in that the higher-boiling nonaromatics, and these are the lowest octane constituents of a reformate, are least soluble in the solvent. On the other hand, the aromatics and the lower-boiling nonaromatics, both of which are the high-octane components, are relatively more soluble and are removed from the extractor with the rich solvent.

Dissolved hydrocarbons are removed from the rich solvent by stripping, yielding a gasoline of well-balanced boiling range as the high-octane product of the process. Lean solvent from the stripper is returned to the extractor to complete the solvent cycle.

Recycle operation . . . In the Rexforming process, the reaction section can be operated at mild conditions to produce an effluent having an octane number of 75 to 85 F-1 clear and containing 35-45 per cent aromatics. The extraction section serves to separate from this effluent a stream of increased aromatic content, containing the highest-octane paraffins in the reactor effluent. This stream, the Rexformate, when of 100 clear octane number, will contain 60-65 per cent aromatics.

The remaining low-octane, higher-boiling paraffins are left in the raffinate stream, to be recycled to the reforming section for further processing. Furthermore, minor amounts of aromatics can be left in the recycle raffinate stream without effect on the efficiency of the process. Thus, investment and operating costs for the extraction section are much lower than those for extraction operations designed to make pure aromatics at high recoveries.

Production of Super-Fuels

In earlier papers on reforming we have stressed that for an ideal operation all components of the charging stock should be converted into higher-octane-number materials. We have also emphasized that the ideal process should be effective for a wide variety of charging stocks.

The usual charge stocks to reforming operations contain small amounts of aromatics, the remainder being naphthenes and paraffins. The aromatics are of excellent octane quality, and are stable at reforming conditions.

The primary reaction of naphthenes in catalytic reforming is the essentially complete conversion to aromatics by dehydrogenation.

Paraffin reactions . . . Paraffins undergo three reactions: isomerization, hydrocracking, and dehydrocyclization. The isomerization reaction is the fast-

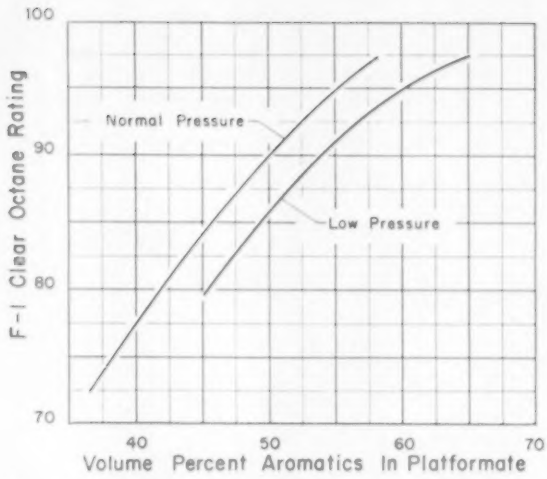


Fig. 4—Effect of operating pressure on aromatic contents of Platformates from Kuwait naphtha.

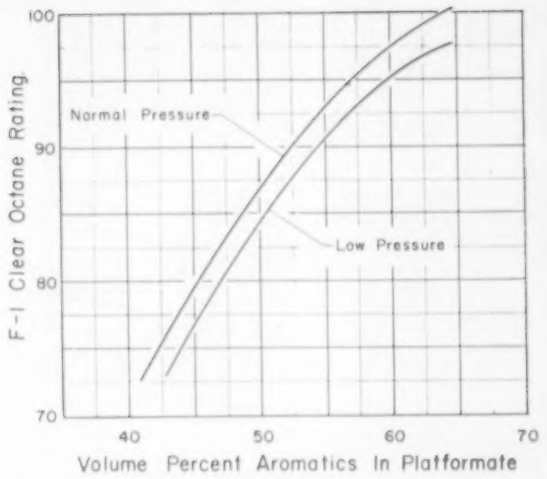


Fig. 5—Effect of operating pressure on aromatic contents of Platformates from Mid-Continent naphtha.

est of the three but it is useful only at moderate octane levels because the equilibrium mixture contains substantial proportions of low-octane paraffins.

Hydrocracking is a potent means for upgrading the higher-molecular-weight paraffins, which are of extremely poor octane. The octane-number increase obtained is very substantial, and yields are excellent due in large part to the fact that the products are of lower density than the parent hydrocarbons. However, the extent of this reaction must be properly balanced with the other reforming reactions because of volatility specifications.

Dehydrocyclization, or the conversion of paraffins to aromatics and hydrogen, is an important and effective means of improving octane ratings. The fact that this reaction involves a substantial volumetric loss due to both density change and production of hydrogen is overshadowed by the extremely large octane increase. The extent to which dehydrocyclization proceeds in once-through operations is limited by the fact that as aromatic concentrations increase, the rate of additional dehydrocyclization is drastically reduced.

Because of these factors, all once-through reaction products contain small, but important, amounts of residual low-octane paraffins. The presence of such materials constitutes a very real barrier to the production of super-quality fuels by once-through operations.

Reformate composition . . . To investigate this point, a study was made of the nature of the nonaromatic hydrocarbons, principally paraffins, present in a variety of Platformates. The octane ratings of such materials vary with feed-stock naphthenicity and boiling range, as well as reforming operating conditions and conversion level, so that no simple relationships exist.

Typical data obtained from Platforming of Mid-Continent naphtha fractions are shown in Fig. 2. For Platformates of 95 to 100 clear F-1 octane rating, the contained nonaromatics range from 20 up to 40 clear octane, with the lower values being associated with the higher-boiling feed naphtha. At higher severities, the nonaromatic portion increases in octane number due to selective removal of heavier paraffins both by dehydrocyclization to aromatics and by hydrocracking to lower-boiling, less-reactive, and higher-quality paraffins.

A detailed examination of the nonaromatic portion of a different Platformate is given in Table 1. The lowest octane ratings are associated with the highest-boiling fractions.

Even a few per cent of the higher-boiling nonaromatics are seriously detrimental in super-octane fuels. Something had to be done to such low-quality nonaromatic hydrocarbons before they could be economically used. A new procedure was required which would eliminate the barrier placed by the low-octane paraffins.

TABLE 1—NONAROMATICS FROM A PLATFORMATE

Fraction No.	Fraction boiling range, °F.	Fraction volume per cent of total	F-1 Clear Oct. No.
1	Up to 115	14.4	
2	115-142	9.9	80.5
3	142-151	10.0	68.7
4	151-157	10.0	47.4
5	157-194	9.9	63.3
6	194-199	10.2	55.6
7	199-219	8.8	18.6
8	219-261	13.0	35.4
9	261-306	8.5	9.3
10	306-349	3.9	3.8
11	Bottoms	1.4	Not determined
		100.0	

Upgrading paraffins . . . One procedure considered for offsetting the presence of low-octane paraffins was operation at reduced pressures. Such an operation increases the production of aromatics, but leaves poorer-quality paraffins in the product. Examination of the curves of Figs. 3, 4, and 5 shows that for three very different feed stocks, lower-pressure operations require higher concentrations of aromatics at given octane levels over the entire octane range. This can only mean that the nonaromatics in these products are of poorer quality at the lower pressures.

Aromatic concentrations in motor gasolines have generally been increasing along with the upward trends in octane ratings. This is the expected result from inclusion of more and more catalytically reformed and catalytically cracked gasolines in refinery outputs. There have been some combustion problems attributed to this trend. Minimizing aromatic contents at the target octane level, therefore, seems desirable.

Aromatic concentrations can be reduced by improving the nature of the nonaromatics. Fig. 6 gives some measure of the extent to which this is practicable at a clear octane level of 96. Here, a 10 per cent decrease in aromatic concentration can be accomplished if the quality of the nonaromatics can be improved from 50 to 65 F-1 clear octane. This effect has been of importance in our approach to the problem of an improved catalytic reforming process.

Extraction step . . . These considerations have led our research staff to the conviction that efficient reforming to super-octane levels can be accomplished only by selective treatment of the low-octane paraffins. The process to accomplish this requires a partial conver-

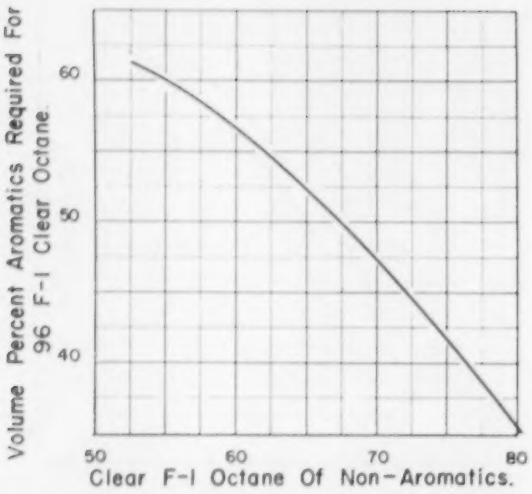


Fig. 6—Reduction on aromatic concentration made possible by improvement of nonaromatics.

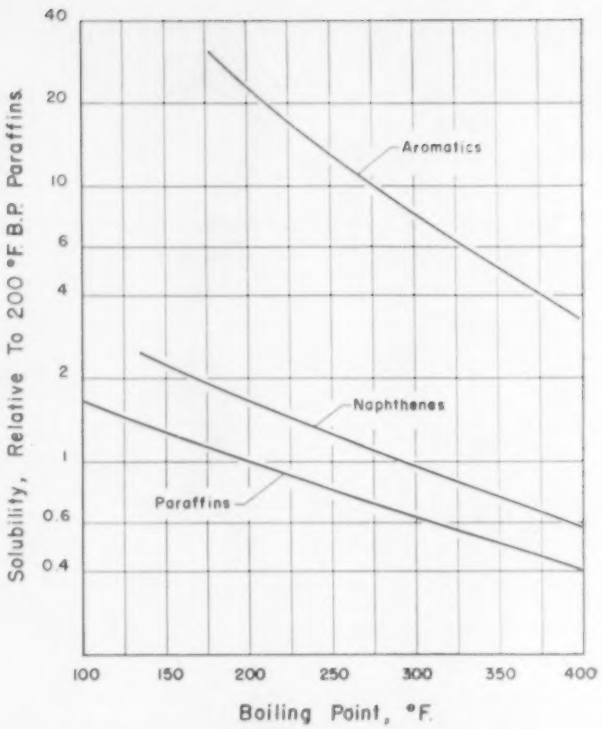


Fig. 7—Relative solubilities of various hydrocarbon types.

sion of such paraffins under mild conditions to maintain a proper balance between the reactions of hydrocracking and dehydrocyclization without undesirable side reactions which produce excessive quantities of gas and coke. This partial conversion of paraffins requires in turn the continuous separation and recycle of unconverted material to the reaction zone.

The application of liquid-liquid solvent-extraction techniques was found to be appropriate, after consideration of alternate separation methods. It developed that by careful selection of solvent and operating conditions, it is practical to selectively dissolve all types of high-octane materials, both the aromatics and the low-boiling nonaromatics. At the same time the high-boiling low-octane components are rejected by the solvent.

Fig. 7 illustrates the relationships involved for a solvent which may be used to dissolve all gasoline-boiling-range aromatics along with the low-boiling, high-octane paraffins and naphthenes. The use of such a solvent permits separation of reactor effluents into a super-octane portion and a low-octane stream. This latter material is then available for selective upgrading to high-octane gasoline, or for special uses such as a refined jet-fuel component or paraffinic solvent.

The low-octane stream may be handled in a separate catalytic reforming section; however, experiments in completely integrated laboratory and pilot-plant units proved that recycle of this material to the catalyst in admixture with raw feed is completely practical. Such operations are characterized by low recycle ratios and high liquid recoveries of very high-octane gasolines.

The established advantages of recycle operations, with their lower conversions per pass are well known to the refining industry. The operating conditions used in Rexforming are distinctly less severe than for conventional once-through operations. The benefits to the refiner are obvious.

100-Octane Operation

A substantial number of runs have been made in completely integrated Rexforming units, both on laboratory and pilot-plant scale. It should be pointed out that the operation of the reforming section determines the composition of the charging stock for the extraction section, while the operation of the extraction section determines the composition of the charging stock to the reforming section. Thus, it can readily be seen that complete integration and uniform continuous operation is essential to obtaining reproducible and accurate data.

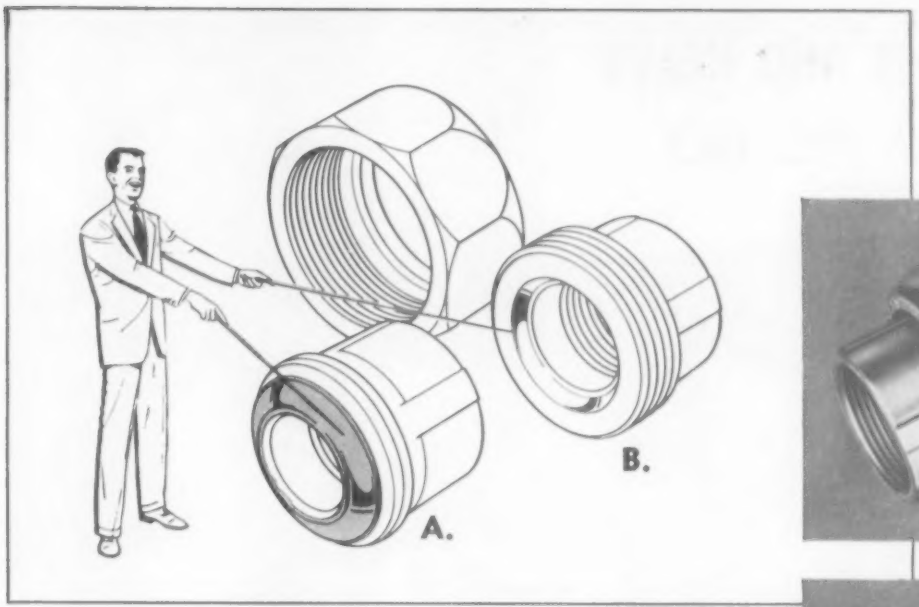
The results, shown in Table 2, were obtained in Rexforming a Mid-Continent naphtha in a laboratory unit. The octane-number range covered by these tests is from about 95 to 102 F-1 clear. The aromatic contents of the Rexformates corresponding to these octane numbers range from 56 to 77 per cent, and the lower-boiling fraction contains the higher-octane paraffinic components, while the higher-boiling fraction is essentially completely aromatic.

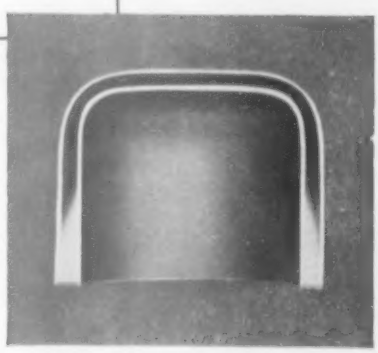
Low-severity operation . . . One of the most interesting features of these Rexforming runs is the relatively low severity required for the production of these octane numbers. For example, both tests in Table 2 were run at the same temperature level. This temperature was more than 50° F. lower than would be required for once-through operation to the lower product octane number shown.

TABLE 2—LABORATORY REXFORMING DATA, MID-CONTINENT FEED STOCK

Test No.—	Charge	1	2
Inspections of Rexformate:*			
Gravity, °A.P.I.	52.5	44.3	37.3
F-1 clear octane	30.0	95.2	†101.8
Aromatics, volume per cent	8	56	77
100 Ml. dist.:			
I.b.p., °F.	248	124	120
5 per cent	264	162	160
10 per cent	270	180	189
30 per cent	289	249	288
50 per cent	312	297	326
70 per cent	340	339	353
90 per cent	370	382	392
95 per cent	379	402	413
E.p., °F.	390	426	429
Yields:			
Separator gas, s.c.f./bbl.		856	1,090
Debutanizer gas, s.c.f./bbl.		246	296
Debutanized Rexformate, vol. per cent		82.9	76.8
10-Psi. R.v.p. Rexformate, vol. per cent		92.3	85.0

*Debutanized. †C.R.C. octane scale extension.





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Special engineering design and processing creates this hardness differential and the toughness you've been needing in replacement and new work. AISI Molychrome steel and *special* heat treating give the male seat its greater degree of hardness . . . preventing galling in "making up."

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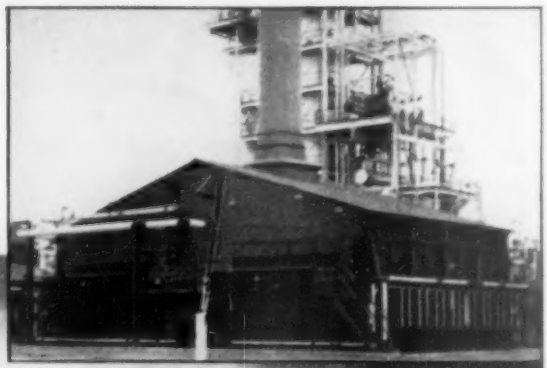

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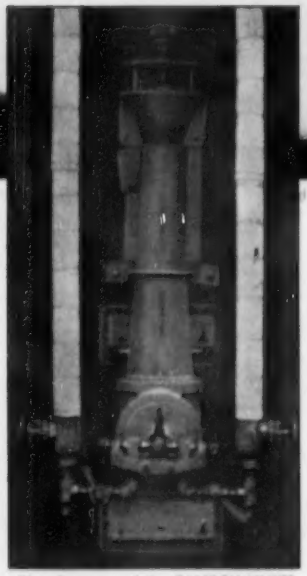

Showing one of the TANDEM UNITS in action . . . and photo at top right is an exterior view of the Crude Heater.

WITH NATIONAL AIROIL OIL-GAS TANDEM COMBUSTION UNITS

The unretouched photograph above shows the interior of one end of a double-ended Crude Heater Furnace. Each end of this furnace is fired with eight (8) National Airoil "Airocool" Gas and Oil TANDEM COMBUSTION UNITS. Note how controlled *fuel oil* flames remain horizontal throughout the correct length of flame for maximum radiant absorption withut impingement on bridge wall or roof tubes.

The TANDEM UNIT has a high turn-down ratio with a steady flame . . . maintains high flame temperature with either fuel oil or gas; can be brought quickly to full capacity with a clean fire. Also it is ideal for high "visk" fuels, including asphalt bottoms.

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In addition, space velocities utilized were higher on the basis of fresh feed than those ordinarily employed for once-through operations at considerably lower octane levels. The combination of the mild processing conditions and selective extraction made it possible to attain the high octane numbers with good yields.

It is difficult to make a valid comparison in yield at 100 clear octane number between Rexforming and once-through operations, because once-through operations suffer from instability at the requisite very severe operating conditions. These also have a very adverse effect upon the yield-octane relationship. Undoubtedly, the yield differential between Rexforming and once-through operations increases with increasing octane numbers.

High-paraffin stocks . . . Table 3 shows the results obtained in processing a highly paraffinic naphtha. This charging stock was deliberately selected to demonstrate the versatility of Rexforming. Product of over 100 clear octane was produced from this, the highest-paraffin-content (85 per cent) naphtha that we have been able to locate without going to synthetic materials. The yield of the high-octane-number fuel is less than that obtained from the Mid-Continent naphtha, which is to be expected in view of the considerably higher paraffinicity of the charging stock.

Table 4 shows the properties of the various streams obtained in Rexforming pilot-plant operation. These data were obtained on a Mid-Continent naphtha feed. The most important point is the relatively low octane number of the reactor effluent, indicating that a very mild reaction severity was utilized. A 41-octane-number recycle stream was separated from the reactor effluent and recycled to commingle with fresh feed. Thus, the feed to the reactor was increased by about 40 per cent. Since a higher space velocity was used in this case, less catalyst was actually required than for conventional once-through operations.

The over-all result is shown in the last column, where the product is of good volatility characteristics, has a clear octane number of 97.2 and was obtained in a yield of 80.5 per cent by volume. Although in this particular operation the low-octane stream was completely recycled, all or a portion of this material may be withdrawn as a net product.

Due to the facts that this stream is essentially free of such materials as olefins and sulfur compounds, and in addition contains more than 90 per cent paraffinic hydrocarbons, it is ideally suited for inclusion in such valuable specialty products as jet fuels, which are of growing volume in refinery production schedules.

TABLE 3—LABORATORY REXFORMING DATA—LOW-NAPHTHENE FEED

Inspections:	Charge	Rexformate
Gravity, °A.P.I.	59.6	47.1
F-1 clear octane	10.3	101.0
Naphthenes, volume per cent	12	
Aromatics, volume per cent	3	59.2
100 Ml. dist.:		
I.b.p., °F.	254	110
5 per cent	265	153
10 per cent	268	167
30 per cent	282	239
50 per cent	296	278
70 per cent	320	306
90 per cent	351	345
95 per cent	365	364
E.p., °F.	390	415
Yields:		
Separator gas, s.c.f./bbl.		940
Debutanizer gas, s.c.f./bbl.		484
Debutanized Rexformate, vol. per cent		68.2
10-P.s.i. R.v.p. Rexformate, vol. per cent		74.3

TABLE 4—PILOT-PLANT REXFORMING DATA—MID-CONTINENT FEED STOCK

Inspection data:	Fresh charge	Rerun bottoms	Combined feed	Stabilized reactor effluent	Low octane recycle	Debutanized Rexformate
Gravity, °A.P.I.	52.3	29.5	56.1	52.4	63.4	47.0
F-1 clear octane	33.0			76.3	41.0	97.2
Aromatics, vol. per cent	9			37.5	8.5	53.5
100 Ml. distillation:						
I.b.p., °F.	242	417	168	133	114	93
5 per cent	259	431	227	172	148	109
10 per cent	264	436	241	194	165	121
30 per cent	292		271	245	225	173
50 per cent	316		298	280	266	262
70 per cent	346		332	313	300	309
90 per cent	374		367	366	355	367
95 per cent	384		376	387	378	393
E.p., °F.	415		395	424	420	424
Quantities, volumes per 100 volumes net feed	101.4	1.4	144.6	125.1	44.6	80.5

TABLE 5—ESTIMATED INVESTMENT AND OPERATING COSTS FOR REXFORMING

Basis: 5,000 bbl. per stream day Mid-Continent full boiling straightrun gasoline* producing 101 F-1 clear Rexformate. (See Fig. 1.)

	Total
Erected cost (within battery limits)	$1,600,000
Operating costs, cents per barrel full boiling gasoline:	
Operating labor at $2.75 per hour	4.0
Laboratory	1.0
Utilities:	
Fuel at 15 cents per M.M. B.t.u.	7.3
Power at 0.8 cent per kw.-hr.	4.0
Steam at 30 cents per M. lb.	4.6
Water at 1 cent per M. gal.	1.4
Catalyst	6.9
Solvent	1.7
Maintenance at 3 per cent of investment per year (labor and materials)	2.8
Insurance and property taxes at 2 per cent of investment per year	1.9
Total operating costs excl. royalty, depreciation, administration, and overhead	35.6

*4,300 bbl. per stream day fresh naphtha charge to reactor section.

Economics of Rexforming

The approximate investment and operating costs for Rexforming are given in Table 5 on the basis of charging 5,000 bbl. per stream day of full-boiling Mid-Continent straightrun gasoline and producing 101 F-1 clear Rexformate in a flow as outlined in Fig. 1.

"For Pete's sake, shut up!—You're scaring away all the oil!"

It is thus estimated that the Rexforming process for this type of operation costs about $300 per barrel to install and about 36 cents per barrel to operate including the costs itemized in Table 5. These are reasonable costs when it is considered that the product is of such high quality.

No valid cost comparison with established once-through operations can be made at this high octane level. It should be pointed out, however, that the increased yield from Rexforming makes this process economically attractive even at the lower octane levels at which real comparisons can be made. In some cases the economics of Rexforming can be further improved by diverting the highly paraffinic recycle to jet-fuel uses.

by J. Brent Malin

REFINER'S NOTEBOOK

LUBE-OIL ADDITIVES—1

Using Oxidation and Corrosion Inhibitors

NEW engines — with more and more power per cubic inch of displacement.

More demands on the oil—engine builders and engine owners expect the oil to cool, cleanse and protect, as well as lubricate the engine. And they want it to do this for long periods.

Intense competition—this is perhaps the most influential factor in development of superior lubricating oils for the modern internal-combustion engines.

These superior oils were achieved by: (1) better selection and refining of petroleum to make the base oil; and (2) reinforcement of this oil with desirable additives.

Additives . . . Present high-grade lube oils may contain some or all of the additives listed below. In many cases a single additive may belong in more than one of the classes.

1. Antioxidants and bearing corrosion inhibitors.
2. Detergent-dispersants.
3. Rust or corrosion inhibitors.
4. Viscosity index improvers.
5. Pour point depressants.
6. Antifoam materials.
7. Film strength agents.
8. Dyes.

Some oils reach additive volumes of 25 per cent. But base oil is important. Additives alone are not a substitute for high oil quality. At the same time, the base oil alone, regardless of its quality, cannot satisfy the stringent requirements imposed by modern operation.

However, when proper type of additives are blended with well-refined base oils, the over-all result is a commercial oil that enables modern engines to deliver thousands and thousands of miles of satisfactory, trouble-free service.

The discussion of additives can become confusing if one attempts to cover all additives at once. Approximately a thousand patents have been issued on lube-oil additives.

Author is with E. I. du Pont de Nemours & Co., petroleum chemicals division.

There is also lack of a precise understanding as to just how the various additives function. The theories which seem to be most generally accepted will be summarized and presented without qualification.

It is also possible to exhibit innumerable photographs of engine parts and reams upon reams of charts and tables to illustrate the "before and after" effects of additives. It is unfortunate that actual test data can cover only specialized portions of the field. Information of this type usually must be obtained under some specified set of test conditions and any results are usually limited by those conditions.

Oxidation inhibitor . . . This is one of the most essential additives for a lubricating oil. Nearly all the hydrocarbons present in lubricating oils are oxidizable under the severe conditions of temperature, metallic catalysts, and violent agitation which exists in an engine for rather prolonged periods. Without such inhibitors, oil oxidation occurs and some very undesirable effects such as bearing corrosion and ring sticking are encountered.

The intermediate products of oil oxidation have not yet been well defined. But one of the first steps seems to be the partial oxidation of unstable molecules to form organic peroxides. These may be further oxidized to aldehydes or alcohols and subsequently become ketones or organic acids and end products.

Other end products may consist of partially oxidized and polymerized hydrocarbons of high molecular weight. In the first case, and particularly with paraffinic oils, the organic acids so formed are highly corrosive to engine bearings made of copper-lead and cadmium alloys which are used to withstand high-load conditions. In the case of the larger, partially oxidized molecules, they tend to become viscous and are likely to give rise to ring sticking and valve-stem and piston deposits.

Oxidation of naphthenic-type hydrocarbons results primarily in highly complex condensation and polymerization products as are commonly found in high-temperature sludges and in the resinous lacquers found on piston skirts. Oxidized naphthenic hydrocarbons do not have such strong tendencies to form organic acids as do the paraffinic hydrocarbons.

How do they function? . . . The exact mechanism by which oxidation inhibitors function is, like the oxidation process, largely unknown. They are believed to terminate free-radical chain reactions, and to attack the organic peroxides which are formed as intermediates and decompose them to harmless products.

This action serves to disrupt any further oxidation. Thus inhibitor additives do not prevent oxidation of the oil. But they do tend to nullify the harmful end effects and are, in a sense, consumed by the reaction.

Bearing corrosion inhibitors . . . There are also some materials that serve principally to inhibit bearing corrosion and which also act as catalyst poisoners or metal passivators. These additives seem to combine chemically with the metal of the bearing surface and form a complex sulfide or phosphite layer. This coating is considerably more corrosion resistant than is the parent metal. Consequently, it can withstand the attacks of small amounts of acids that might be formed despite the inclusion of an oxidation inhibitor.

Similarly, these same compounds tend to coat other fresh metal surfaces and to destroy possible catalytic effects that may be exerted on oil oxidation. The surface coating may be present as either an adsorptive surface coating or as a chemical bonding, such as a sulfide layer.

Although separate chemical compounds are sometimes used as oxidation and bearing-corrosion inhibitors, it is possible also for some single compounds to exhibit both antioxidant and bearing-corrosion control.

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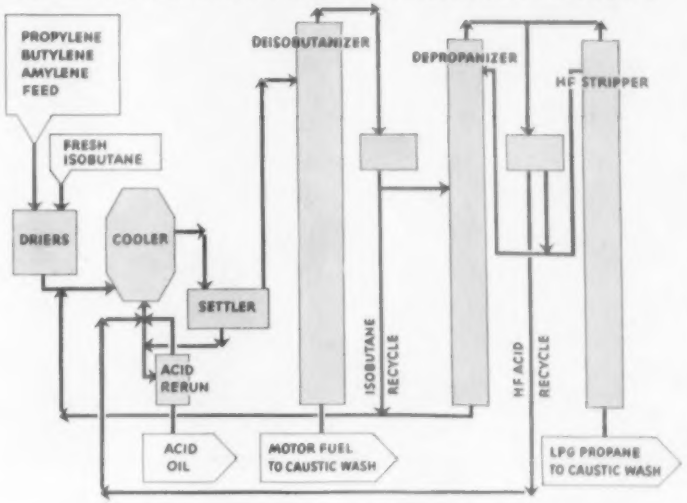
PERCO HF ACID ALKYLATION PROCESS FOR MOTOR FUEL PRODUCTION



Liquid feed, containing olefins and isobutane, is passed through driers and fed into a cooler along with liquid recycle hydrofluoric acid. Hydrocarbons and recycle acid then flow to the settler. The acid phase is recycled to the cooler. The hydrocarbon phase is fractionated to separate high octane motor fuel alkylate from recycle isobutane.

Meet the increasing demand for higher octane motor fuels with Perco HF Alkylation. A Perco plant is exceptionally economical to install and operate. Find out how Perco HF Alkylation increases octanes and profits. For complete information consult Perco today.

Here are **10** benefits you get with **PERCO**

1 High octane and high blending value.

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4 Creates no gum problem in any blend.

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Pipeline Patrol

. . . Report on Construction

Shenandoah Gas Co. Puts New Line in Operation

Shenandoah Gas Co., of Winchester, Va., has recently put a 40-mile, 6-in. line between Middletown, Va., and Martinsburg, W. Va., into operation. The line connects with the Atlantic Seaboard Corp. at Middletown. Somerville Construction Co., of Ada, Mich., did the work on the line which was completed the last part of March. In the picture, G. Frank Stinnett, general manager of Shenandoah, inspects a valve fabrication near Stephens City, Va.

Under Way, Contracted, and Planned

PIPELINE activity as reported below by the Oil and Gas Journal is compiled from information received from pipeline companies and contracting firms.

These projects include those planned, proposed, under way, and contracted. Uncontracted projects are indicated by • preceding the job.

Crude-Oil Pipelines

Ar-Mex Pipe Line Co.—Company has applications for two lines before the Office of Defense Mobilization Board for rapid amortization approval.

1. A crude-oil line from Albuquerque, N. M., to Phoenix, Ariz. This line would serve a 20,000-bbl. refinery being planned by Frost & Associates of Dallas.

2. A crude-oil line from Guernsey, Wyo., to Albuquerque.

• **Magnolia Pipe Line Co.**—Company will begin construction soon on 215 miles of 12, 14, and 16-in. pipeline along its crude-oil system from Midland to Corsicana, Tex. The expansion program also calls for doubling of pump horsepower of the six pump stations to a total 21,600 hp.

Magnolia Petroleum Co—This company will operate a 48-mile, 12-in. submarine pipeline for itself and Continental Oil Co., and Newmont Oil Co. The line will run to blocks off the coast of St. Mary's Parish, Louisiana, and will have a capacity of 50,000 bbl. per day. Brown & Root, Houston, has the contract and expects to be finished by the middle of 1955.

Minnesota Pipe Line Co.—Williams Brothers Co. has contract to build this 260-mile, 16-in. crude line from Clearbrook to Hastings, Minn. The line, to cost $12,500,000, is the southern end of a system which will move crude from Fosterton field, Sask., to Great Northern's refinery which is building in the Minneapolis-St. Paul area. Present plans call for completion by July 1955.

Shell Oil Co. and Murphy Corp.—These companies have announced plans for a 450-mile, 16-in. crude line from eastern Montana south into Wyoming. The line will deliver to big-inch carriers which start in eastern Wyoming.

Standard Pipe Line Co.—Company plans to build two crude lines. Applications are now before the Office of Defense Mobilization for rapid amortization approval.

1. A 350-mile, 16-in. crude line from Glendive, Mont., to Guernsey, Wyo., to connect with Platte Pipe Line Co.'s system there.

2. A 330-mile, 16-in. crude line from Wink, Tex., to Albuquerque, N. M. This line would serve a 10,000-bbl. refinery being planned by Frost & Associates of Dallas.

Pipeline Patrol

Texas New Mexico Pipe Line Co.—Firm has awarded contracts for 74 miles of crude lines in eastern New Mexico and West Texas. Ferguson Construction Co., of Eunice, N. M., will lay 43 miles of 8-in. from Maljamar station in Eddy County, New Mexico to Tulk pool in Lea County and Drickey pool in Chaves County, New Mexico. McVea & Barlow, Inc., Odessa, Tex., will lay 24 miles of 8 and 10-in. from Dora Roberts Ranch in Midland County, Texas, to Basin Pipe Line System's station at Midland, Tex.

Trans Mountain Pipe Line Co.—Engineers Limited Pipeline Co. has contract to lay 27 miles of 20-in. from Laurel to Burlington, Wash., and 9 miles of 16-in. of lateral to Shell Oil Co.'s new refinery at Anacortes, Wash. The $2,750,000 job will begin in spring and end in mid-summer.

• **Union Oil Co. of California.**—Planning construction of a 60-mile crude line from its Clara Valley field to its Wilmington refinery. 12-in. line. Bids being asked.

• **West Coast Pipeline Co.**—The off-again-on-again plans for this crude line from near Wink in West Texas to near Norwalk in California are presently before the Office of Defense Mobilization. A three-man board of nonindustry members recently recommended that the project be dropped. They questioned the ability of West Texas to produce enough crude to supply both the East and West Coasts in time of war. The three-man board favored building a line from California's Elk Hills Naval Reserve to be held in standby for possible future need.

Products Pipelines

• **American Pipe Line Co.**—Has received ODM approval to amortize 40 per cent of $178,000,000 with a rapid writeoff on proposed line to run from Gulf Coast area to New York City area. Bids for pipe requested.

• **H. W. Bass & Sons, Inc.**—Company is planning on a 152-mile, 4-6-in. L.P.G. line from Goliad Corp.'s plant in Live Oak County, Texas, to Corpus Christi.

• **California-Oregon Pipe Line System.**—103 miles 6-in., proposed, Crescent City, Calif., to Medford, Ore.

Cimarron Valley Pipe Line Co.—Subsidiary of Chicago Corp. is building an 81-mile, 6-in. products line from Chamlin Refining Co.'s refinery at Enid, Okla., to Oklahoma City. River Construction Co., of Fort Worth, is doing the work.

Great Lakes Pipe Line Co.—Company has awarded contracts in two sections on its 163-mile, 10-in. line between El Dorado, Kans., and Kansas City, Mo. Ray L. Smith & Son, Inc., are laying a 91-mile spread between El Dorado and Burlingame, Kans. M-R Co., Wichita, is working on the remaining 72 miles into Kansas City.

• **International Pipe Line, Inc.**—132 miles 8-in., proposed, Wrenshall to Minneapolis, Minn. Cost: $4,200,000.

• **Keystone Pipe Line Co.**—Company has ODM writeoff of 25 per cent for $1,875,000, 48-mile, 8-in. products line from Boot, Pa., to the Fullerton, Pa., terminal.

Malco Pipeline, Inc.—Company planning to build a 91-mile, 6-in. products line from its Prewitt, N. M., refinery to Albuquerque.

Moore Stoner Co.—Company has $2,500,000 tax amortization for a 200-mile, 6-in. products line from a connection with Oil Basin Pipe Line Co.'s terminal at Glendive Mont., to Minot, N. D.

• **Products Pipe Line Co.**—This subsidiary of Goliad Corp. has received a fast writeoff for 40 per cent of $126,000 and 25 per cent on $1,781,000 for L.P.G. line from the Wilcox natural-gasoline plant in Lavaca County, Texas, to Texas City. Panama-Williams Co. has contract. Completion scheduled for mid-summer.

Shell Pipe Line Corp.—65 miles of 12-in. products line from Baton Rouge, La., to Shell's Norco refinery. Houston Contracting Co. has contract. H. T. Muckley, Supt. Job held up indefinitely by right-of-way difficulties.

Sioux Oil Co.—Company will build a 55-mile products, 8-in. line from its Newcastle, Wyo., refinery to Rapid City, S. D.

Southern Pacific Pipe Lines, Inc.—This subsidiary of Southern Pacific Railroad Co. has announced plans for 800 miles of products line from Los Angeles to El Paso. Line sizes are 16-in. from Los Angeles to Colton, Calif., 12-in. from Colton to Phoenix, Ariz., and 10 and 8-in. from El Paso to Phoenix. Products will be pumped both ways into Arizona.

• **Sunflower Pipe Line System.**—Company proposes to build a 215-mile, 6-in. line to transport L.P.G. from six counties in western Kansas to Wichita. Application approved by Kansas Corporation Commission.

Texaco-Cities Service Pipeline Co.—Company is laying 45-mile, 8-in. products line from Tulsa to Cushing, Okla. O. R. Burden Construction Corp. has the contract. Line is expected to be finished in April. Company will also build a pump station at Tulsa and two 30,000-bbl. tanks at Cushing.

Texas Eastern Transmission Corp.—Company has asked FPC permission to abandon "Little Inch" gas line. If permission is granted, company will spend $13,000,000 converting the line to a products line with a capacity of 235,000 bbl. per day.

U. S. Gov't. Alaskan Products Pipe Line.—600 miles of 8-in. under way from Haines northward through Yukon to Fairbanks, Alaska. Williams Bros., McLaughlin, Inc., and Marwell Construction Co. are doing the work. Pipeline work completed.

Natural-Gas Pipelines

• **American-Louisiana Pipe Line Co.**—1,171 miles of 30 and 22-in., 30-in., proposed,

This isn't exactly the problem we're referring to, but the need for an automatic shut-off valve can be just as drastic.

The Enardo tank shut-off valve is completely automatic. You can therefore eliminate those second trips to close the tank valves. When the pipeline valve is turned on, the Enardo shut-off valve locks in the open position. When the oil reaches a predetermined shut-off level in the tank, the valve will close automatically. Check valves are available in ALL models, saving installation of extra checks.

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In Scarsdale, N. Y.—John R. Philip, Inc., plumbing and heating contractors, converted this regular house trailer to a "pipe shop on wheels." Takes Toledo No. 1-2-4 to any job. Has gas engine generator—saves paying for pole line on job. Saves transporting the 1-2-4 to job and back to shop. Saves building a shanty—locks trailer at night. Also serves as office. Speeds up pipe threading anywhere!

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★ *Threads 2" pipe in 18 seconds,* 3" in 30, 4" in 42.

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★ *Instant size change . . .* separate quick-opening die head for each size pipe.

★ *High production . . .* reduces your costs! Order through your supply house.

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TOLEDO

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Pipe Wrenches
Power Pipe Machines

TOLEDO'S FINEST PIPE TOOLS

Pipeline Patrol

extends from North Tepetate, Acadia Parish, Lousiana, to near Detroit. The 22-in. starts near Payne, Ohio, extends to Bridgman, Mich. Estimated cost: $130,000,000. FPC approved.

• **Arkansas Louisiana Gas Co.**—136 miles of new line proposed, to be added to present system in Arkansas, Louisiana, and Texas. Estimated cost: $9,245,166. FPC approved.

• **Carolina Natural Gas Corp.**—185 miles 2-12-in., proposed later lines off Transcontinental in North and South Carolina.

• **Central Hudson Gas & Electric Corp.**—Company has filed application with FPC to construct 48 miles of 12-in. line from Albany to Kingston, N. Y. Line will be started and completed in 1955 if FPC approves.

• **City of Dalton, Ga.**—Proposes to build 39 miles of 8-in. from a point of interconnection with Southern Natural's Rome-Calhoun transmission line. Estimated cost: $2,940,000.

• **Clinchfield Coal Corp.**—Company has filed permit with Federal Power Commission for authority to build 16-mile, 12-in. line from Dickenson County, Virginia to near Osborne Gap, Ky. The company is primarily a coal producer.

• **Colorado Interstate Gas Co.**—365 miles 22-in., approved by FPC, Green River, Wyo., to Denver, Colo., 1954.

• **Colorado-Western Pipe Line Co.**—454 miles of undetermined size pipe planned between Cortez in Montezuma County and Denver. Line would serve towns of Montrose, Gunnison, Salida, Fairplay and South Platte, Colo. Estimated cost: $30,000,000. Company also plans 254 miles of laterals to service Colorado cities not now receiving natural gas.

328-mile line, proposed, to run from a point in La Plata County in southwestern Colorado over the Continental Divide along the eastern slope to serve Pueblo, Colorado Springs, and Denver. Estimated cost: $21,600,000.

• **El Paso Natural Gas Co.**—Company has future plans for a 370-mile, $35,000,000 line from Mountain Home, Idaho, to Reno, Nev. The company will buy the gas from Pacific Northwest Pipeline Co.

• Company plans to build 74 miles of natural-gas line and 6,925 additional compressor hp. in Texas, New Mexico, and Arizona. The cost will be $13,869,017. FPC approval received.

• **Hope Natural Gas Co.**—Proposing to build a 22½-mile extension of existing line from Boone County, West Virginia, to Logan-Mingo County line, West Virginia. Estimated cost: $930,000.

• **Houston Texas Gas & Oil Co.**—Company has proposed an 18-24-30-in. line from South Louisiana to Florida. Preliminary engineering, market surveys are completed. Early filing with FPC is anticipated by company.

• **Kansas-Nebraska Natural Gas Co., Inc.**—Proposes to construct 206 miles of 6-12-in pipeline to add to present system in central and northeastern Nebraska.

• **Manufacturers Gas Light & Heat Co.**—40 miles, proposed, Allegheny, Washington and Beaver counties, Pennsylvania.

213 miles, 3 to 26-in., proposed, various points on system in Pennsylvania, West Virginia, and Ohio.

72 miles, 16-20-in., Doddridge, Wetzel and Marshall counties, West Virginia. Fulghum Contracting Co. doing work.

• **Michigan Consolidated Gas Co.**—25 miles, 12-in., proposed, from near Sparta to Muskegon, Mich.

• **Michigan Wisconsin Pipe Line Co.**—251 miles, proposed, 24, 18, 12, 6, and 4-in loops. Majority will be in Wisconsin.

• **Missouri Public Service Co.**—136 miles, 8-10-in., proposed, New Franklin to Trenton, Mo.

24 miles, 10-in., Johnson County to Clinton, Mo. FPC approved. Est. cost; $600,000.

• **Montana-Dakota Utilities Co.**—Proposes to build 56 miles of 2, 4, and 6-in. line from its 12-in. Cabin Creek - Bismarck line near Gladstone, N. D., to the towns of Lefor, Regent, New England, and Mott, N. D.

• Proposed 34½ miles of 12¾-in. line to run from Baker-Glendive field in Montana to Rapid City, S. D., and 14 miles of 12¾-in. to replace various lines in Park County, Wyoming, and Carbon County, Montana.

Natural Gas Pipe Line Co. of America.—Company has proposed a 280-mile line from Wise County, Texas, to Panhandle field in Texas where it would connect with the NGPLCA to Chicago.

Natural Gas Producers, Inc.—This subsidiary of Colorado Interstate Gas Co. has approval of the Colorado Public Utilities Commission for a 48-mile, 10-in. line from northeastern Colorado to Denver. The com-

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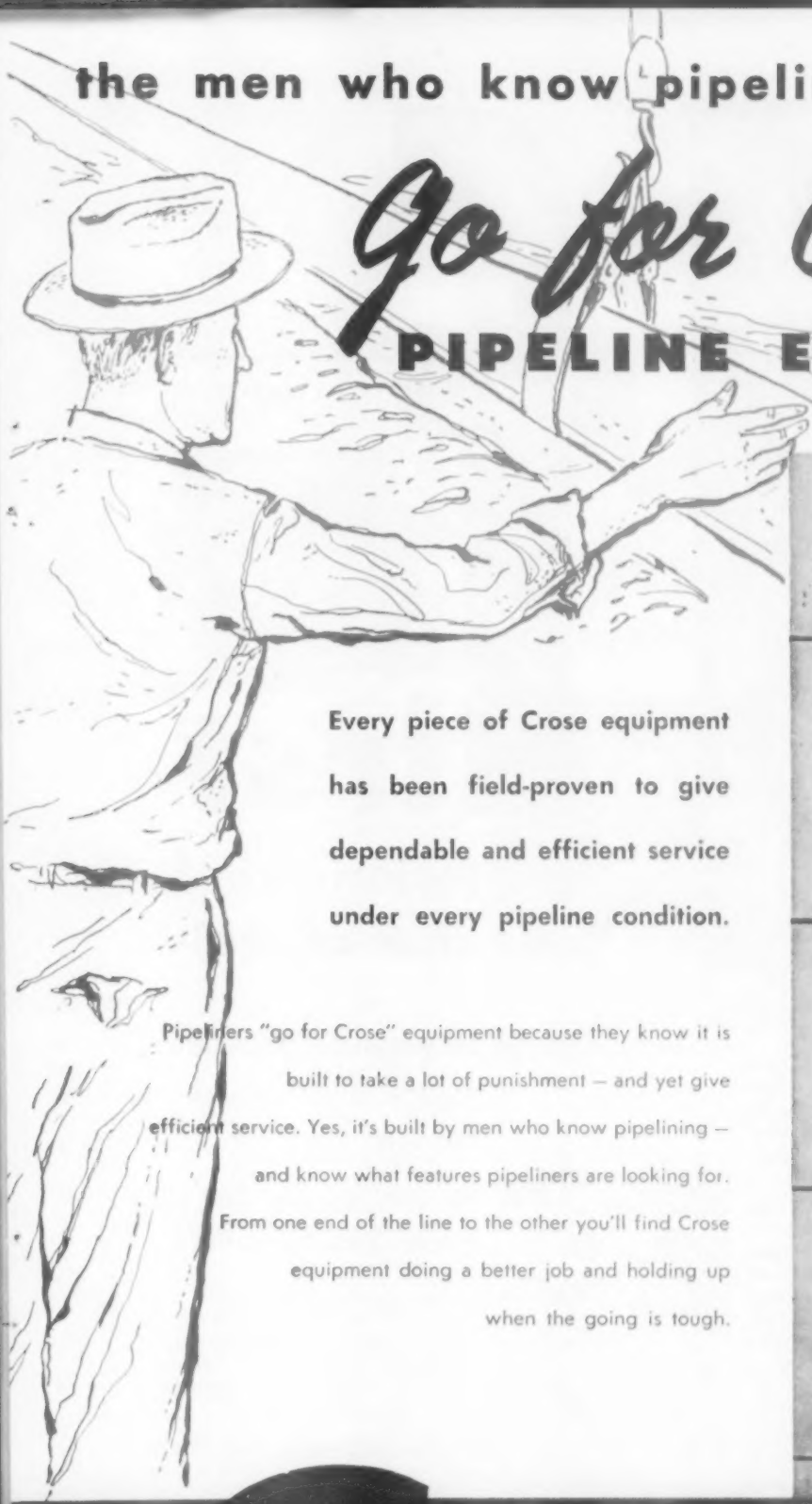
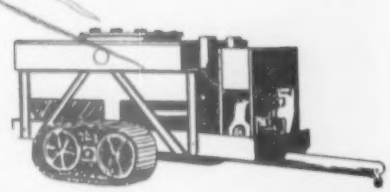
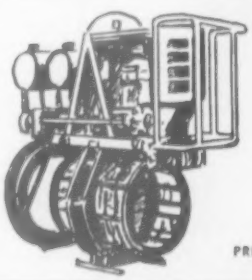
PIPELINE EQUIPMENT

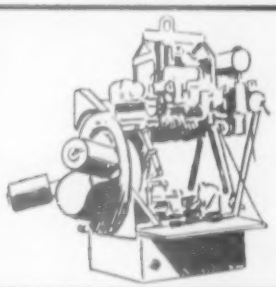




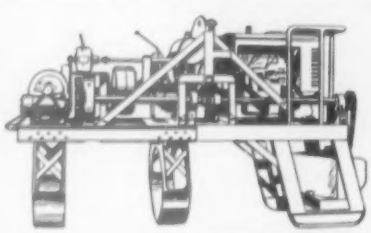
CROSE-LITTLEFORD PIPELINE KETTLES



CROSE CLEANING & PRIMING MACHINES



CROSE COATING & WRAPPING MACHINES



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Every piece of Crose equipment has been field-proven to give dependable and efficient service under every pipeline condition.

Pipeliners "go for Crose" equipment because they know it is built to take a lot of punishment — and yet give efficient service. Yes, it's built by men who know pipelining — and know what features pipeliners are looking for. From one end of the line to the other you'll find Crose equipment doing a better job and holding up when the going is tough.

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Pipeline Patrol

pany will also build 3 miles of 8-in. and 10 miles of 4-in. Entire project will cost $1,374,000.

Nevada Natural Gas Co.—Company plans looping program along its 114-mile line from Needles, Calif., to Las Vegas, Nev. Mileage and size are unknown but cost will be about $2,500,000.

• **New River Gas Co.**—50 miles, planned. Summers to Monroe counties, West Virginia to Narrows and Dublin, W. Va.

• **North Dakota Natural Gas Co.**—This company has moved back into the gas picture in North Dakota with a bid to build a 274-mile, $11,017,200 system from Tioga to Fargo to Grand Forks. An original application filed several months ago was complicated by a later application filed by Northern Natural Gas Co., to serve the same area.

• **Northern Indiana Fuel & Light Co.**—35 miles, 8-in., planned, Edgerton to Auburn, Ind.

Northern Natural Gas Co.—Company has just recently finished a large summer expansion. Still planned are:

170 miles of 20-24-in. line in Minnesota and Wisconsin running to Duluth and Superior.

400 miles of 24-in. line from the Canadian border to tie in with its system at St. Paul-Minneapolis.

500 miles of 24 or 30-in. planned across North Dakota from Tioga past Minot to Fargo and from there eastward to the Twin Cities.

• **Northwest Alabama Gas District.**—40 miles, 9-in., proposed, Southern Natural's line through Winfield to Haleyville, Ala.

• **Pacific Northwest Pipeline Corp.**—1,466 miles, proposed, Ignacio, Colo., to Bellingham, Wash. Approved by FPC.

380 miles, proposed, laterals and spurs off main line to Pocatello, Idaho, to Yakima, Wash.

• **Pine Tree Natural Gas Co.**—204 miles of undetermined size pipe to run from the Boston area to Bangor, Me.

• **Shenandoah Gas Co.**—40 miles, 3-4-8-in., proposed, Middleton, Va., to Martinsburg, W. Va. Est. cost: $1,470,000. FPC approved.

• **South Georgia Natural Gas Co.**—368 miles, 2-12-in., planned, Phenix City, Ala., to Tallahassee, Fla. (a) 12-in., Phenix City, Ala., to Albany, Ga., (b) 10-in., Albany, Ga., to Moultrie, Ga., (c) 8-in., Moultrie, Ga., to Tallahassee. Est. cost: $9,000,000. FPC approved.

• **Southwest Alabama Gas District.**—150 miles, 10 and 8-in., planned, Phenix City to Dothan, Ala. Engineering Const. Co.

• **Tennessee Gas Transmission Co.**—Company has FPC authority to build 243-mile, 24-in. line from Hebron storage field in Potter County, Pennsylvania, to existing facilities near Greenwich, Conn. Company will also build an 18-mile connecting line between Hebron storage field and Harrison storage field.

Tennessee Gas Transmission Co.—Houston Contracting Co. has contract for 57 miles of 20-in. natural-gas line from Kinder, La., to near Pecan Island, La. F. A. Silar is superintendent of the 30-mile stretch from Kinder to Intracoastal Canal, and E. C. Norris is superintendent on the remaining 27 miles.

Company seeks F.P.C.'s approval for a 370-mile 30-in. line from Agua Dulce, Tex. to Kinder, La.

• **Texas Eastern Transmission Corp.**—Proposed, 382-mile, 24-in. line from Kosciusko, Miss., to Beaumont, to connect with the existing 30-in. line there to Connellsville and replace the "Little Inch" in moving natural gas. The project will cost $71,000,000.

• **Texas Gas Corp.**—This firm will spend $3,500,000 on a line from Orange, Tex., to a connection with a new line of Transconti-

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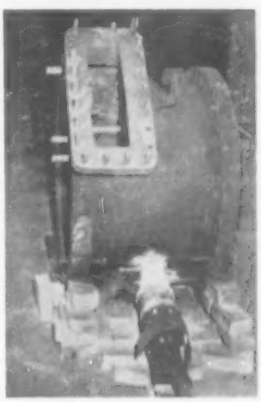
Get Easier Application with Colmonoy Hard-Facing Rod



Preheating valve body prior to hard-facing.

Interior view of slide valve shows applied hard-facing.

Valve gate is overlaid with Colmonoy No. 1.

Colmonoy No. 1 hard-facing electrodes have now been greatly improved. A new metallic coating gives better arc stability and better weldability. Thick overlays are easier to apply because no weld cleaning is necessary between successive passes, and welding may now be done on vertical surfaces. New moisture-proof metal cans keep rods fresh.

The catalyst slide valve shown here lasted five times longer after hard-facing with Colmonoy No. 1 than it did when first installed. Before hard-facing, this western refinery valve had suffered severe erosion, in some places to a depth of over a quarter-inch. Improved Colmonoy No. 1 made reclamation easy and profitable.

Write for the Colmonoy Hard-Facing Manual; you'll learn of many alloys and methods designed to lengthen equipment life.

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How a Sherman Power Digger Does More Work in Less Time with No Standby Equipment

Nearly every department in the city of Hopkins, Minnesota, finds a use for this versatile Sherman Power Digger.

The Water Department uses the machine when cutting off discontinued service lines at the main. They dig a hole in the street (usually blacktop) 3′ wide by 6′ long by 8′ deep. The hole must be plumbwalled for minimum replacement of paving. This operation used to tie up a truck all day, an air compressor half a day, and two men with hand tools, a full day.

Using a Sherman Power Digger, they now do *three* such jobs in one day, with only one man on the digger, no truck, and no compressor, except for concrete pavement. The job goes faster because they can dig the hole, shut off the line, and backfill before the walls begin to cave. Local soil conditions formerly required cribbing many of these excavations.

If *your* work involves the construction or maintenance of underground facilities, you will profit with a Sherman Power Digger. It's compact, fast, and flexible, with low initial cost and amazing economy of operation. Write today for full details, without obligation. Ask for Bulletin No. 1512.

*Designed, Engineered and Manufactured Jointly by Sherman Products, Inc., Royal Oak, Michigan, Wain-Roy Corporation, Hubbardston, Mass.

•

Patent No. 2-303-852
Other Patents Pending

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PRODUCTS, INC.
ROYAL OAK, MICHIGAN
POWER DIGGERS* • FRONT END LOADERS • FORK LIFTS

Pipeline Patrol

nental Gas Pipe Line Corp. in Cameron Parish, Louisiana. The project will call for crossing the Sabine River, building a compressor station, and a measurement station.

Texas Gas Transmission Corp.—Company has applied to F.P.C. for permission to build 207 miles of line along its system from Louisiana to Indiana.

• **Transcontinental Gas Pipe Line Corp.**—Company has plans for 315 miles of 36-in., 231 miles of 30-in., 23 miles of 16-in., 23 miles of 12-in. from Trenton to Woodbury, N. J. 12 miles of 24-in. to connect with Tennessee Gas Transmission's system in New Jersey. The program will loop parts of Transco's present system and will cost $80,000,000. 173 miles of the 30 and 36-in. and the 58 miles of the 12 and 16-in. lines have already received FPC approval.

• **Utah Natural Gas Co.**—Planning 40 miles from Orem to Salt Lake City, 16-in. pipe at later date. Contract not yet let.

Virginia Natural Gas Co.—153 miles, Buckingham to Richmond and Portsmouth, Va.

Foreign Crude-Oil Pipelines

• **Atlas-Dresser.**—Included in this company's agreement with the Argentine Government are plans to build a 400-mile, 16-in. crude line from Plaza Huincul area to Bahio Blanca.

Bombay Port Trust.—50 miles, 8 to 24-in., contracted, Bombay, India, to serve Standard Vacuum Oil Co., and Burmah Shell refineries. Merritt, Chapman & Scott Corp., contractors. (Crude and Products). Collins Const. Co. has subbed 84,000 ft. of Subaqueous work. Shutdown for Monsoon season during summer. Work was resumed September 15.

Compania Shell De Venezuela.—Company will build a pipeline from its Block I field off the western shore of Lake Maracaibo to its terminal at Palmarejo. The line will be known as "Lapline" and will run 18 miles in the lake and 27 miles on land. The underwater section will be 16-in., and the remainder will be 24-in.

Peace River Oil Pipe Line Co., Ltd.—Company plans to build a 16-in. line connecting Sturgeon, South Sturgeon, and Little Smoky fields in Alberta to a planned 106-mile, 12-in. line which would move the crude south to Trans Mountain Pipe Line Co.'s Edson, Alta., station.

• **Petroleos Mexicanos.**—145 miles, 12-in. considered, 18 de Marzo field via Reynosa to Monterrey, Mexico.

100 miles, planned, Isthmus of Tehuantepec, Jose Colomo to El Plan field, Minatitlan.

72 miles, 12-in., proposed, Poza Rica to Atzacapotzalco, Mexico.

Texas Petroleum Co.—Contract has been let to Foster Wheeler Corp. and Panama-Williams for a 119-mile, 12-in. crude line to move oil from Velasquez field in Colombia to a connection with the main Andian National system at Galan. Est. cost: $6,000,000.

• **Yacimientos Petroliferos Fiscales Bolivianos.**—170 miles, 4-in., planned, Bermejo to Tupiza, Boliva.

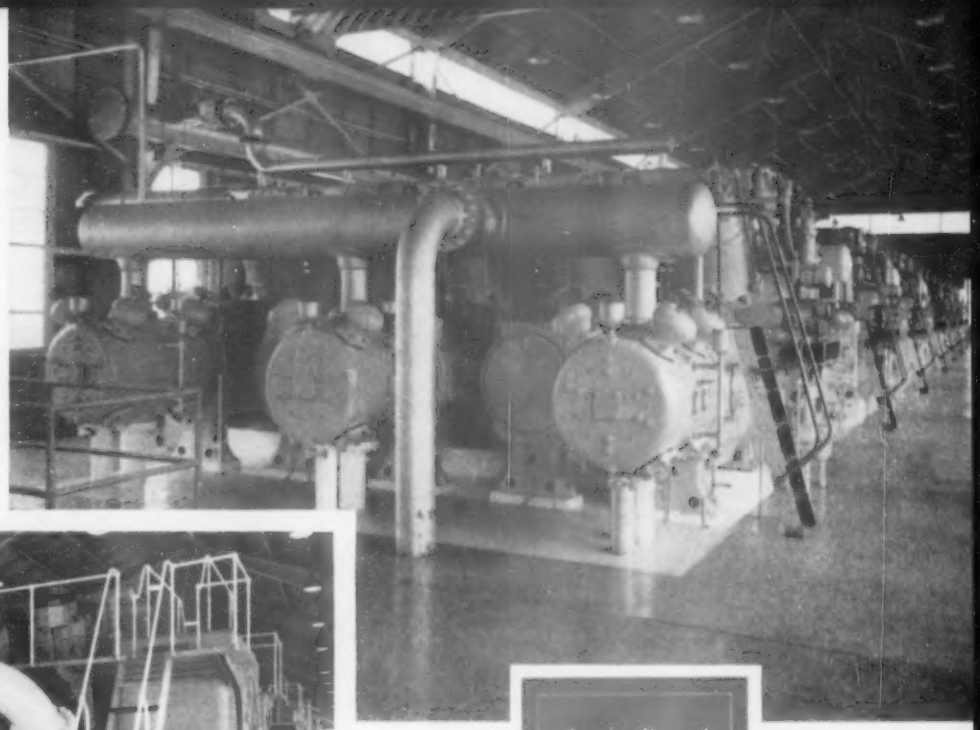
Yacimientos Petroliferos Fiscales Bolivianos.—Bolivian Government oil organization has awarded contract to Williams Brothers Sudamericana, Ltd., to construct a 6-in. crude line from Camiri field to Yacuiba on the Argentine border. The project will cost approximately $2,500,000.

Foreign Products Pipelines

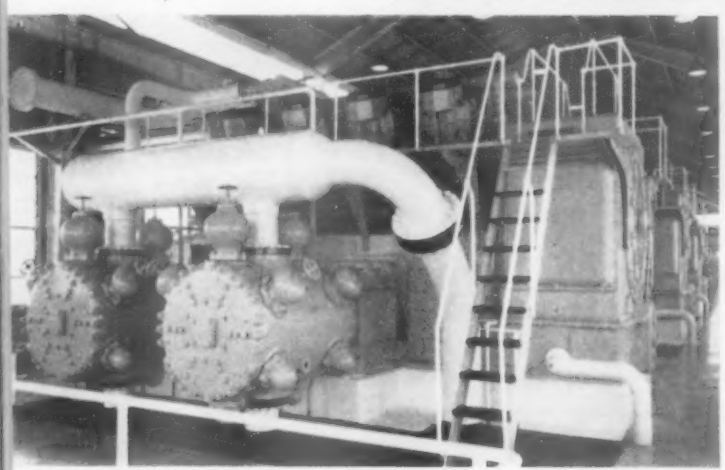
• **Empresa Nacional del Petroleo.**—80 miles, 6⅝-in., planned, Concon to Santiago, Chile.

• **Governments of South Rhodesia and Portuguese East Africa.**—200 miles, consid-

Shown here are a few of the twenty-nine GMV's at the Batesville, Miss., station of Tennessee Gas. In addition to these 1000 hp Cooper-Bessemers, there are three 8-cylinder, 2000 hp GMW's — all delivering gas in volume well above their performance guarantee.



Close-up of the compressor cylinders on one of the three 2000 hp GMW V-angle units in operation at the Portland, Tenn., station of Tennessee Gas Transmission. A total of thirty Cooper-Bessemers comprise this large installation.



Another Example of Efficient Power at Lower Cost

How **COOPER-BESSEMER** power progress meets the **T·G·T EXPANSION**

WHEN the Tennessee Gas Transmission Company's first line was completed in 1944, Cooper-Bessemer 1000 hp GMV's furnished more than half of the system's entire compressor horsepower — the nation's first major pipeline powered with angle compressors exclusively. Since then many more Cooper-Bessemer V-angles have been added — the bulk of them GMV's. And throughout its history, this huge line has always exceeded its design capacity.

Today, the GMVA and GMWA, Cooper-Bessemer's latest V-angle compressor developments, offer unmatched power-to-space advantages. Add to this better-than-ever fuel efficiency with reduced heat load, and you can appreciate why and how TGT and other lines benefit so much by Cooper-Bessemer progress in compressor power.

Right now Cooper-Bessemer has further new developments underway that give every promise of still better things to come. So, to best meet compressor requirements today, *and* tomorrow, weigh the value of proved performance and progress such as this TGT example . . . and by all means check with Cooper-Bessemer on the very latest ways to cut the over-all cost of compressor service.

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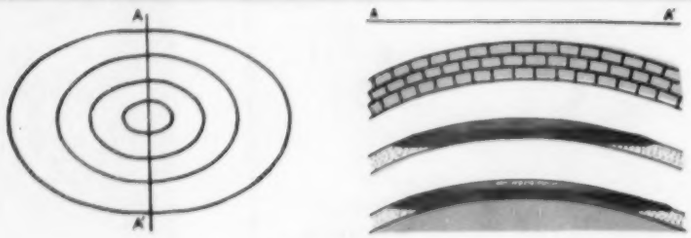
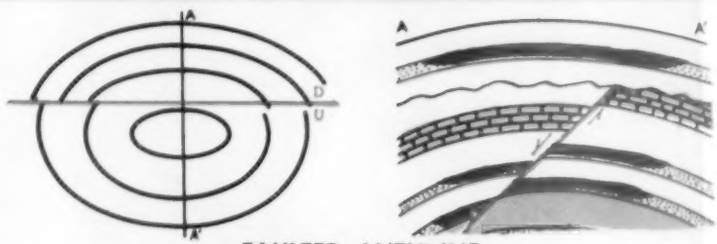
ANTICLINES



ANTICLINE

Anticlines are found in nearly all oil provinces and are a very important oil trap. Their importance was recognized even before the drilling of Drake's discovery well in 1859. Today the anticlinal theory has taken a backseat to to the "trap theory," but oil finders are seeking still such structures all over the world. The relief of these anticlines varies greatly, ranging from tens of feet to several thousand. Some of the largest oil fields of the world are anticlinal traps. The Abqaiq pool in Saudi Arabia is a tremendous anticline, 25 miles long and 6 miles wide; this structure produced about one billion barrels of oil in 8 years. The Abqaiq anticline contrasts sharply with the small Wilcox structures of central Oklahoma that cover only 100 acres.

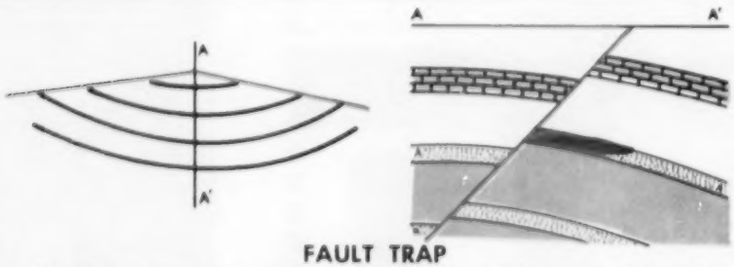


FAULTED ANTICLINE

Many of the larger anticlines of the world are faulted. The fault patterns range from the simple type shown to the exceedingly complex patterns found in the Rocky Mountains and in California. Production is usually confined to the upthrown block. This, however, should not entirely eliminate the downthrown side of the fault as a potential trap since such production does occur under favorable conditions. In this type of structure the role of faulting appears to be of minor importance in controlling accumulation on the crest of the fold. Faulted anticlines occur in nearly all geologic provinces and can usually be mapped by geophysical surveys.

In the example shown, the faulted anticline is masked by the unconformity and later deposition.

FAULT TRAPS



FAULT TRAP

Normal or gravity faults control production in many oil fields in most of the geologic provinces of the world. This type of trap occurs wherever the region has been folded or uplifted. Often the trap is formed by a combination of both folding and faulting.

Fault traps may occur along regional fault systems such as the Mexia-Talco fault zone in Texas. Fields occur in a narrow belt along this fault system for nearly 400 miles.

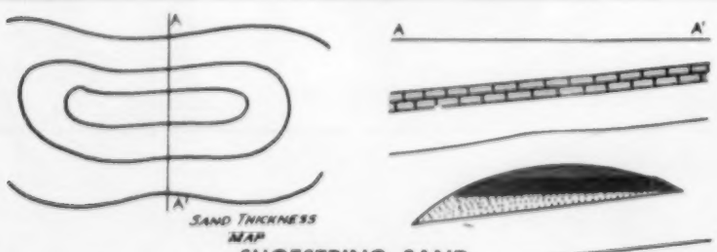
Fault planes formed by gravity or tension usually dip at 45-60°. Invariably, wells that pass through a normal fault drill an abnormally short section of sediments. The thickness of the missing section is equal to the throw of the fault. This is a good criterion for locating the fault if there is enough well control.

COMPLEX FAULT TRAP

Faulting often breaks an oil field into several separate pools or fault blocks. The faults may parallel each other as shown, or they may intersect to form the traps. The fault patterns can be related to the regional and local geology as a general rule; this serves as a useful guide in exploring for new fields or extending the known producing areas.

Faulted fields in Texas and Louisiana are very common, but they can occur in nearly all geologic provinces. They are most common in areas that have been uplifted or that have been subjected to tension during the geologic past. Both local and regional uplift may form these traps. In addition, complex fault patterns often develop on large folds; these faults may form separate reservoirs on the larger structure.

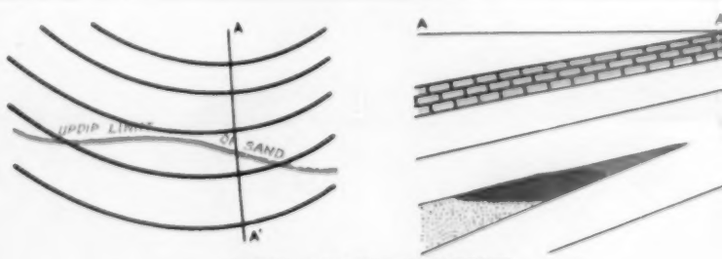
STRAT TRAPS



SHOESTRING SAND

Nearly one-third of the important oil fields of the United States are stratigraphic traps and these were discovered by random drilling rather than by scientific exploration methods. This indicates that "strat traps" are fairly common in the subsurface and make up a tremendous undeveloped oil reserve.

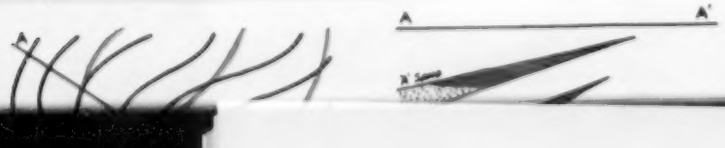
One of the more common types of strat traps is the shoestring sand. These were probably formed as offshore bars, or possibly in old river channels. The shoestring sands of Kansas and Oklahoma are typical. These traps are fairly small as a rule and form lenticular oil fields. Such fields are difficult to find because of their size. Geophysicists consider, however, that shoestring sands can be mapped under favorable conditions.

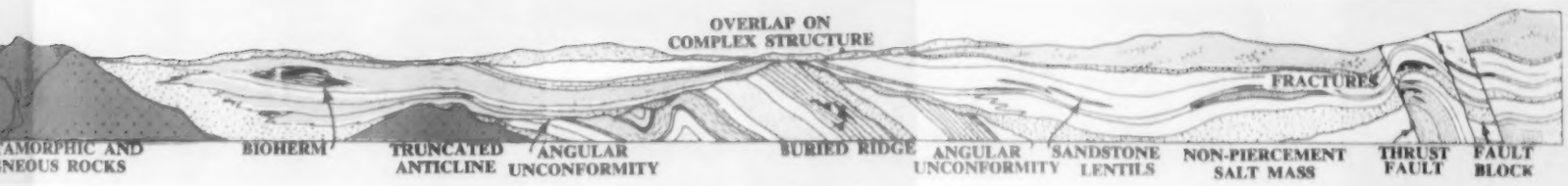


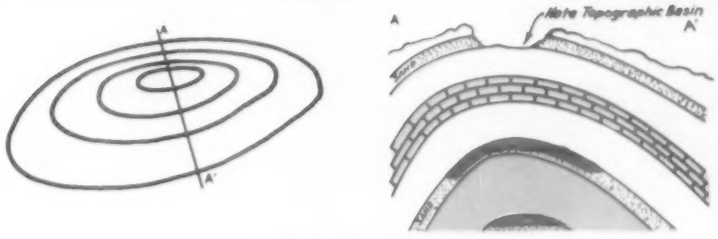
UPDIP SAND PINCHOUT

These traps form when a porous sandstone grades updip into a shale or tight limestone. Pembina in Alberta is a good example of this type of trap. These pinchouts may represent old strand lines and extend for many miles along a fairly narrow belt at the updip limit of the sand. Although sand pinchouts are stratigraphic traps, folding and faulting may be important in controlling production.

Sand pinchouts occur in many geologic provinces throughout the world. Detailed subsurface geology is the best method of finding those strat traps where well control is adequate.

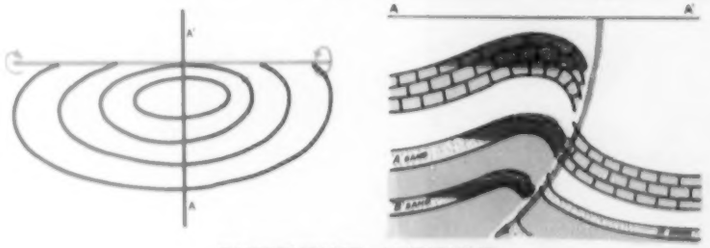






ASYMMETRICAL ANTICLINE

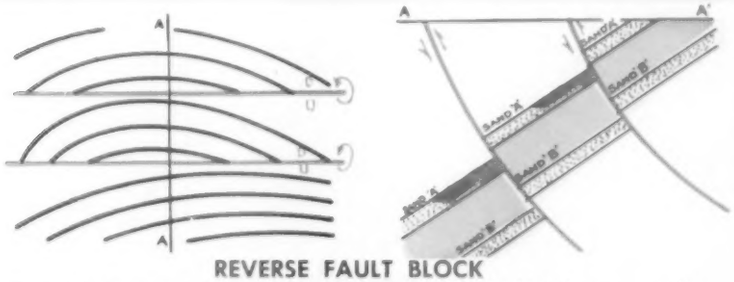
Asymmetrical anticlines as a rule are formed by compression. They are found in any geologic province where compression has played an important role. Typically these structures are elongate and often occur in trends that parallel the major uplifts of the geologic province. Many of the surface anticlines in the Rocky Mountains fall in this category. Frequently the center of the surface anticline forms a topographic basin where erosion has cut through a resistant bed. The resistant bed forms a prominent scarp or rim-rock that is easily recognized. The axis of the symmetrical anticline may shift with depth. As a consequence, the deep-seated fold may not lie directly under the surface anticline.



OVERTHRUST ANTICLINE

Overthrust anticlines are formed by compression and occur along the edges of major uplifts as narrow folded belts. These belts are one of the most important future oil provinces of the world. The geology in these thrust belts is exceedingly complex, but the structures are prolific and may develop into major fields. Turner Valley in the Alberta foothills of Canada is a classic example of an overthrust fold and has produced over 100 million barrels since its discovery in 1915.

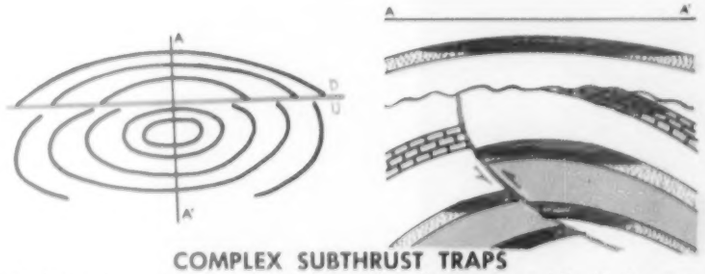
The complex geology and high cost of exploration have retarded active exploration in the overthrust areas, but offer tremendous oil possibilities to the aggressive oil company.



REVERSE FAULT BLOCK

Reverse faulting normally occurs in areas that have been subjected to compression. Wells that pass through these fault planes will normally repeat section, going from older beds above the fault into younger beds below the fault. Reverse or thrust faulting occurs around the flanks of mountain uplifts where horizontal compression plays a dominant role in the forming of local and regional structures. The oil possibilities along the flanks of these major uplifts has not been fully exploited and these areas offer a rich field for the oil finder.

Although this type of trap is not common today in oil exploration, in the future its role will increase.

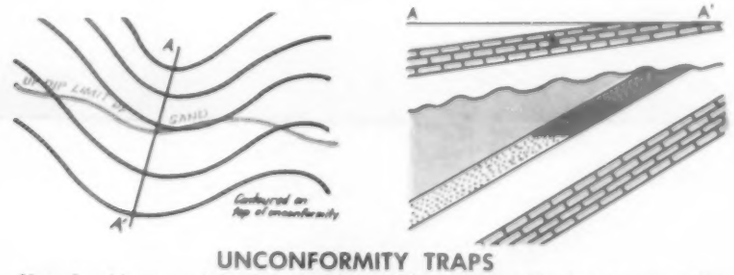


COMPLEX SUBTHRUST TRAPS

Production in overthrust areas has largely been confined to the anticline in the overriding block. Theory indicates that several fault traps should exist on these complex folds and study of certain known fields supports this conclusion.

The importance of overthrust belts is increasing as drillable prospects become harder to find. Oil companies are now studying all thrust belts as potential oil provinces.

Subthrust production occurs in several areas in the world and undoubtedly will increase in importance as oil companies explore the thrust belts. Subthrust traps in the United States are found in the Rocky Mountains, southern Oklahoma, and California.

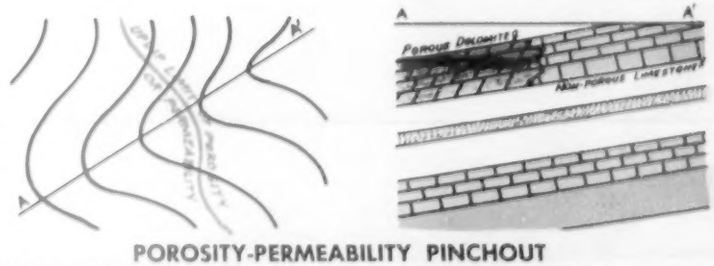


UNCONFORMITY TRAPS

Unconformities or periods of erosion followed by later deposition can form prolific oil field traps. Oil in the producing sand is trapped against the overlying impermeable beds. The most familiar unconformity sand trap in the United States is the East Texas field; it has produced over 3.1 billion barrels of oil since its discovery.

Unconformities are extremely important because many oil fields in the world are associated with them.

Although the figure shows a truncated sand, unconformities may trap oil in limestones or dolomites. Many of the Arbuckle limestone pools of Kansas are of this type.



POROSITY-PERMEABILITY PINCHOUT

This type of strat trap occurs where a porous and permeable rock grades into a nonporous rock. These pinchouts may be of local or regional importance. Frequently porous dolomite grades updip into a nonporous limestone to form the trap. The Carthage gas field in East Texas is an excellent example of a permeability pinchout; the producing Pettit limestone grades updip into an impermeable limestone that is barren; later arching of the sediments formed the Carthage pool that covers nearly 250,000 acres.

Porosity-permeability pinchouts are hard to find and require adequate well control. Detailed subsurface studies are the most effective way of finding such elusive traps.

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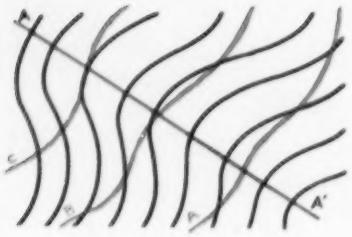
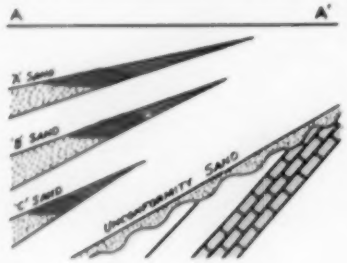
adequate.

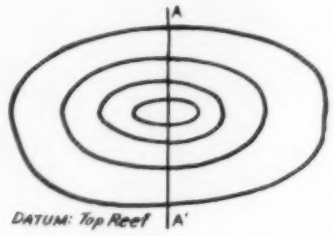
STRAT TRAPS

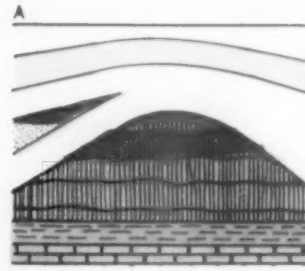




ONLAP

When a sea invades an area, several sands may be laid down. These sands may represent old shore lines as the sea advances over the area. The younger sands extend further updip. Each sand is a separate reservoir, and several trends are developed. Such trends can extend for many miles with production confined to the regional noses or highs. The Cotton Valley sands in North Louisiana produce along a trend or "fairway" a distance of over 100 miles. Seismic methods can delineate these pinchouts under favorable conditions; however, subsurface control is necessary to outline the sand limits.

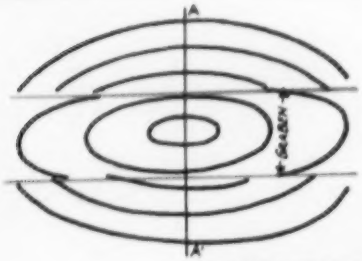


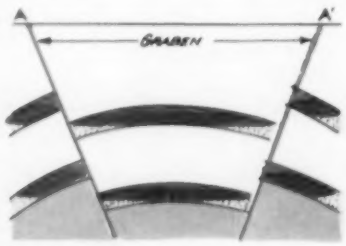


REEFS

Reefs are productive in many parts of the world. Many types exist, such as at table reefs, barrier and fringing reefs, biostromes and bioherms. Although reefs may o in folded areas, the folding is not of importance in controlling production. As a sequence, the reefs are hard to find. They occur as elongate domal features that may may not be reflected in the overlying sediments. Some reef trends extend for hundred miles. The size of the reef-producing area ranges from a few acres to several sq miles. The importance of reefs in exploration thinking has increased during the few years, largely because of the prolific production along the Scurry-Snyder trend of West Texas and on the Devonian reef trend of Alberta.

SALT STRUCTURES

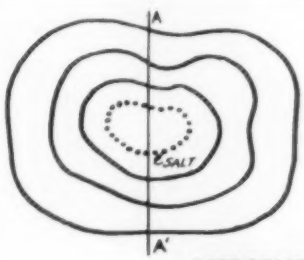


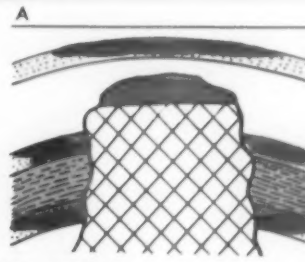


DEEP-SEATED SALT DOME

Traps related to salt movements are of tremendous importance to the oil industry. Deep-seated salt domes are common along the Gulf Coast of the United States. Production on the deep-seated domes is usually associated with normal faulting. The wells on deep-seated domes as a rule do not penetrate the salt that lies below the producing formations.

Both gravity and seismic surveys are extremely useful methods of searching for salt dome features. Geologists suspect that many of the structural features in East Texas and North Louisiana are also related to deep-seated salt movement.





PIERCEMENT SALT DOME

Piercement domes produce along the Texas and Louisiana Gulf Coast as well other parts of the world. The central salt plug or core has been forced upward thr the overlying sediments. Production occurs in many different traps on piercement domes. Complex faulting frequently is present and these faults may control produc Although the faults are normal gravity faults as a rule, thrust or reverse faulting been reported on the Boling dome in Texas.

The salt is often overlain by a caprock composed of limestone, gypsum, sulfu anhydrite; and this caprock may produce.

Salt domes occur in many sedimentary basins of the world.

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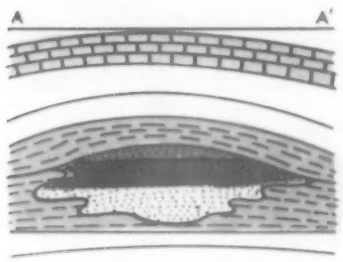
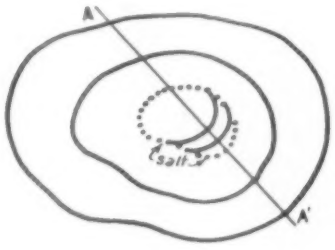
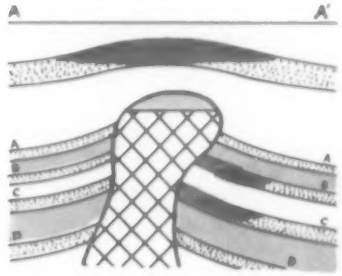


DELTAS

Deltas are a special form of stratigraphic trap and were deposited by ancient rivers. According to D. A. Busch, there are 3 main types: bird's foot, estuarine, and arcuate. The arcuate delta appears to be the most important as a potential oil trap. Several Pennsylvanian sand fields in Oklahoma are deltaic in origin. It is probable that the role of deltas in exploration thinking will increase as more subsurface control becomes available. Detailed subsurface studies are the best way of finding these traps; the sand development is often erratic and it is difficult to extend the limits of the sand.





COMPLEX TRAPS ASSOCIATED WITH SALT DOMES

A salt dome field produces from a wide variety of traps. The arched beds over the salt are only one possibiltiy. In many domes the salt or caprock overhangs or juts out over the invaded sediments. Production may occur beneath this overhang.

Complex faults are typical of salt domes and these trap the oil. A salt dome field may produce from 10 or 20 separate reservoirs, or even more because of the faulting and sand conditions. Even the caprock is a reservoir in certain Gulf Coast fields. Flanking sands pinch out to form prolific reservoirs on many salt domes.

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Principal oil and gas-producing structures sketched and classified for easy recognition

SYMBOLS

- SANDSTONE
- SHALE
- LIMESTONE
- DOLOMITE
- SALT OR EVAPORITE
- GAS
- OIL
- FAULT
- UNCONFORMITY

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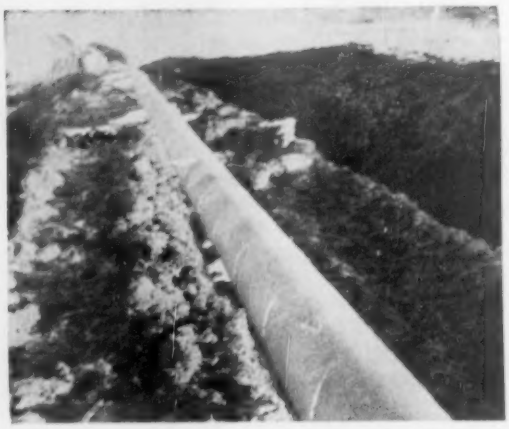

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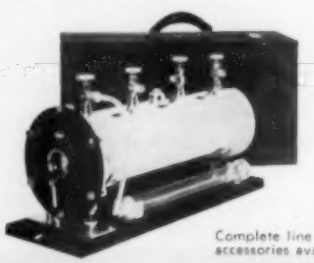

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ered, Beria, Portuguese Mozambique to Umtalia, Southern Rhodesia.

• **National Fuel Oil Co.**—This company in Israel is a shareholder in a company which plans to build a products line between Haifa and Tel Aviv. The plans call for a 55-mile, 6-in. line in which the Government would own 10 per cent.

• **North Atlantic Treaty Organization (NATO).**—This defense organization is building products lines to airforce bases in various parts of France. Approximately 2,000 miles of 4-10-in. line will be laid.

Oleoducto del Pacifico, S. A.—Company is building 100-mile, 6 and 8-in. products line from Buena Ventura to Cali, Colombia. Pipeline Engineering Co. of Dallas, Tex., has the contract.

Overland Pipeline Corp.—This South African firm has requested government permission to build a 350-mile line, to cost $8,450,000, from the South African coast to Rand, a plateau area in southern Transvaal where there is heavy petroleum consumption.

• **Petroleos Mexicanos.**—124 miles, 6-in., planned, Lagos to Guadalajara, Mexico.

54 miles, 6-in. planned, Lagos to Aguascalientes, Mexico.

82 miles, 8-in., planned, Salamanca to Lagos, Mexico.

• **United States Government.**—375 miles, 12-in., planned, St. Nazaire to Melun and Metz, France.

• **United States Navy Department.**—Proposed 300-500-mile line to be built in Spain to serve a proposed naval base and four large air bases which are also proposed under a defense agreement with the Spanish Government. No definite size or cost is known now.

Winnipeg & Central Gas Co.—Canadian company plans to build a $20 million butane-propane system. Company plans to get gas L.P.G. from Signal Oil & Gas Co.'s Tioga, N. D., plant and move it to Winnipeg. Size and route of the line has not been definitely established.

Foreign Natural-Gas Pipelines

Alberta Gas Trunk Line, Ltd.—This Canadian firm has let engineering contracts to two firms, Dutton, Williams Brothers, Ltd., and Mannix, Ltd., for a 300-mile, big inch gas-gathering system to collect Alberta's natural gas for transportation to Trans Canada Pipe Line Co.

Attock Oil Co.—Company plans to build 60-mile natural gas pipeline from Dhulian field to Rawalpindi in West Pakistan.

• **Empresa Nacional del Petroleo.**—80 miles, 10-in., planned, Concon to Santiago, Chile.

Petroleos Mexicanos.—205 miles 16-in. under way, Monterrey to Torreon, Mexico.

• **Petroleos Mexicanos.**—440 miles, 20-in., planned, Brazil to Tampico to Poza Rica, Mexico.

Sui Gas Transmission Co., Ltd.—Morrison-Knudsen Construction Co. has contract to build 350-mile, 16-in. line from Sui field to Karachi in West Pakistan. Est. cost: $25,000,000.

• **Trans-Canada Pipe Lines, Ltd.**—Company planning 2,250 miles of 24-34-in. natural-gas line from the Alberta-Saskatchewan boundary to Toronto and Montreal. Also plans a 24-in. lateral from Winnipeg to Emerson, Man. Twenty-inch lateral from Niagara to Toronto now in operation.

Private Interests.—Proposes to build gas line from Gubik gas field near Navy Petroleum Reserve No. 4 in Alaska to Fairbanks. the line would cost $20,000,000, although later figures have been much higher than this. Line would be 450-mile, 8-in. line and Arctic Contractor, Inc., who handled engineering requirements and preliminary design.

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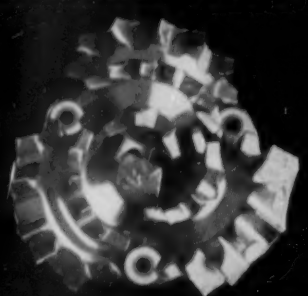

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Drilling Contractors

McVay & Stafford Drilling Co. is scheduled for a 13,300-ft. test to be drilled for Mid-Continent Petroleum Co. in northern Lea County, New Mexico. Location is for 1 State Land 53, a wildcat in 29-11-35, about 9 miles northwest of Tatum.

Vasser & Brown Drilling Co. will drill a 7,500-ft. wildcat in Wilkinson County, Mississippi, for T. S. Stoneman and Vasser & Brown 1 Brown heirs, new Wilcox test ¾ mile northwest of Darrington. The new location is 2,228 ft. from south line, 778 ft. from west line of Section 22, but in 43-4n-1w. It is about 3 miles southwest of Ireland field production.

Brewster & Bartle Drilling Co. has its drilling barge in dry dock for repairs while piling is being driven for Gulf Oil Corp.'s first wildcat off the Florida coast. The wildcat, 1 State of Florida, Lease 326-G, is in 13 ft. of water, 7 miles due south of East Cape on the Florida mainland in Monroe County. It is the first offshore test for Florida.

Justiss-Mears Drilling Co. will drill to 6,800 ft. at the first of two new Lower Cretaceous tests in Baldwin County, southwestern Alabama, for Walter F. Hamilton, C. Dale Armour, and Justiss-Mears. The test is now below 4,000 ft. The well is the 1 H. Howard Patterson et al., C NE NE 12-2n-4e. The second test will also go to 6,800 ft. It is the 2 Patterson et al., C NE NE 8-2n-4e. Nearest production to these wildcat ventures is South Carlton field, 11 miles northwest.

Atlas Drilling Co. has a new contract operation scheduled in the Laurel Ridge area, in Iberville Parish, southern Louisiana. It is a well for F. A. Callery, Inc., at 1 Hibernia. Location is in 68-10s-14e. Hole is projected to 10,700 ft.

O. K. Smith has a rig working for Oceanic Oil Co. at a wildcat location 3 miles west of Skidmore, in Bee County, South Texas. Location is carried as 1 McCracken, in the Patrick Boyle Survey. Permit is for 5,200 ft.

Harvey Drilling Co. will go to 7,500 ft. at a wildcat off St. Bernard Parish, coastal Louisiana, for Charles E. Ratcliff at A-1 State Lease 2293 in the Chanceleur Sound area. The test is on Block 70. Another offshore test will be drilled by Kerr-McGee for Continental Oil Co. at A-1 Lease 2549, Block 55, in the West Delta area off Plaquemines Parish. This will go to 14,000 ft.

Loffland Brothers Co., Tulsa, has two new wildcat jobs under way in Acadia Parish, coastal Louisiana. One is for San Jacinto Petroleum Co. at 1 Adams, in 7-11s-1e, about 6 miles southwest of Crowley, in the southern part of the parish. It is set up for

Daylight and evening tour crews of Clark Fuel Producing Co., and tool pusher F. R. McDonald pose in front of Rig No. 1 working on Owen & Moss's 1 Carl in the El Sanz area north of Rio Grande City, Tex. Front row, left to right: W. E. Houston, driller; W. F. Simon, derrickman; H. W. Shepherd and E. A. Niemietz, floormen, and J. M. Lindsey, mechanic. Back row, same order: W. James, driller; Ray Lewis, derrickman; Kay Spencer and C. C. Buchanan, floormen; and F. R. McDonald, tool pusher.

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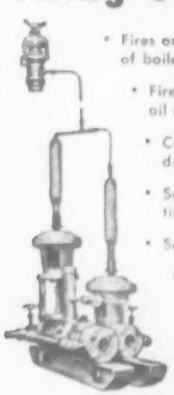

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11,500 ft. The other is for Republic Natural Gas Co. and Monterey Oil Co. at 1 Hession, in 17-9s-2w, 2 miles east of Jennings dome. It will go to 12,000 ft.

Kirkwood & Co., Alice, Tex., is drilling for Seaboard Oil Co. at a wildcat location 2 miles southeast of Placedo, in Victoria County, South Texas. The test, projected to 7,000 ft., is carried as 1 Pickering, with location in the J. M. Brownson Survey.

Jones Drilling Co. is putting down a 2,500-ft. cable-tool test for Layton Schobert and John Terrell, of Fort Worth, at a wildcat location 11 miles southwest of the latter city, in the R. J. Ware Survey, Tarrant County, Texas. Location is on the Mrs. C. H. Bertram ranch.

Rowland Drilling Co. is contractor on a new Superior Oil Co. wildcat operation in Haskell County, eastern Oklahoma. It is a 6,600-ft. test at 1 Pixler, in 14-8n-20e, east of Superior's East Lona gas field, productive from Atoka sand around 5,600 ft.

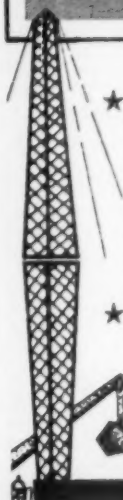
Vickery Drilling Co., Inc., is a new drilling firm at Evansville, Ind. It is owned by W. C. Vickery, who recently acquired the interest of Charles White in a rotary rig they formerly operated in partnership.

Kerr-McGee Oil Industries, Inc., Oklahoma City, has contracted for a 14,000-ft. wildcat test Continental Oil Co. will drill in Block 84, West Delta area, in the Gulf of Mexico off the south tip of Southwest Pass, Plaquemines Parish, Louisiana.

Crag Drilling Co. has been awarded contract for a wildcat test in the Ituna area, of southeastern Saskatchewan, for Tide Water Associated Oil Co. It will be the 3 Ituna Crown, LSD 16, 10-26-11w2, 5 miles northeast of Ituna railpoint, 72 miles northeast of Regina. Crag's rig currently is drilling at the 2 Ituna Crown, 4 miles southwest.

Brinkerhoff Drilling Co., Ltd., Calgary, Alta., is rigging up rotary tools at a Devonian D3 zone wildcat in the Erskine area of central Alberta, about 7 miles northwest of Stettler. Five companies, including Canadian Gulf Oil Co., Texaco Exploration Co., British American Oil Co., Ltd., McColl-Frontenac Oil Co., Ltd., and New Superior Oils of Canada, Ltd., are participating in the operation. The well, 7 Timms, is in LSD 7, 19-39-20w4. It is 1⅝ miles northeast of Erskine Devonian oil production and 5¼ miles northwest of Stettler field.

Technically TOPS



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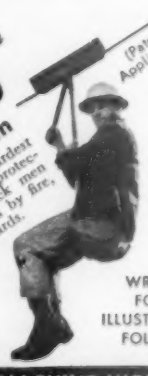

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Duff-Norton Jacks and Coffing Hoists

join to give you more complete lifting service from one source!

It seemed a logical move to combine into one organization the world's oldest and largest manufacturer of lifting jacks, Duff-Norton; and a leading producer of high quality hoists, The Coffing Hoist Company.

That's exactly what happened March 1 when Duff-Norton purchased The Coffing Hoist Company. Now, with the pooling of engineering skills and experience, the joining of sales departments and the combining of two complete lines of lifting tools, you can expect better service when it comes to lifting, lowering, pushing, and pulling jobs from either the floor or ceiling.

Josiah Barrett, the founder of Duff-Norton, invented the world's first ratchet lever jack in 1883. Today, the line of high-quality jacks includes some 203 different types and sizes of ratchet, screw, hydraulic, and air motor powered models from compact 3-ton capacity hydraulic jacks to giant 100-ton capacity air power jacks.

F. W. Coffing, who founded the Coffing Hoist Company in 1928, invented the first ratchet lever hoist and also developed the first portable lightweight electric hoist. Coffing hoists are recognized as high quality, low maintenance products. The Coffing line includes over 100 different sizes and models from 500 pound to 25 ton capacities in ratchet lever, standard and lightweight spur gear, and electric hoists.

See your local distributor or write for complete details on jacks to the Duff-Norton Company, Pittsburgh 30, Pennsylvania. For hoists, write to the Coffing Hoist Division, Duff-Norton Company, Danville, Illinois.

Duff-Norton *Jacks*
Coffing *Hoists*

Giving Industry A Lift Since 1883

EQUIPMENT MEN . . . in the News

Byron Jackson's four new vice presidents: Evan H. Sweet, Norman D. Jesse, Garth F. Nicolson, and Ross Barrett.

Byron Jackson Co. Elects Four New Vice Presidents

At a recent meeting of the directors of Byron Jackson Co., four new vice presidents were elected, according to an announcement by E. S. Dulin, president of the company.

Norman D. Jesse has been made vice president in charge of sales, service, and branches of the Pump Division, Garth F. Nicolson became vice president in charge of the Oil Tool Division, Evan H. Sweet has been appointed vice president and counsel, and Ross Barrett has been named vice president in charge of public relations, advertising, and market research.

Jesse has been with the company since 1939 and is now manager of the eastern branch of the Pump Division with headquarters in New York. Nicolson joined the company in 1934 and served as chief engineer of the Oil Tool Division, rising to general manager of that division prior to his recent election as vice president. Sweet has been associated with Byron Jackson since 1945 and was office legal counsel until his recent appointment. Barrett joined the company in October 1954 as director of public relations.

In announcing the new appointments, Dulin called attention to the fact that Lynn Sawyer, vice president and general manager of the Pump Division, is taking a 6 months' leave of absence from business effective April 1 at his own request. At the conclusion of this leave, Sawyer will return to the company with important new responsibilities to be announced at that time.

Floyd C. Merritt, who was formerly vice president in charge of the Oil Tool Division, and William N. Beadle, formerly a vice president in the Pump Division, both retired from active management of the company in 1954, but are continuing in a consulting capacity.

Tellepsen Makes McLaughlin Assistant Chief Engineer

Howard K. McLaughlin, until recently development engineer with Naugatuck Chemical Division of U. S. Rubber Co., has been appointed assistant chief engineer of Tellepsen Petro-Chem Constructors of Houston, a division of Tellepsen Construction Co.

Prior to his association with Naugatuck in 1951, McLaughlin worked 4 years in design and research for Commercial Solvents Corp.

Johnston Pump Expands Services, Facilities

General expansion of the services and facilities of Johnston Pump Co., a vertical turbine pump manufacturer, and the appointment of A. H. Miller, vice president of Emsco Manufacturing Co., as general manager, have been announced following acquisition of the assets of Johnston Pump Co. on January 31, 1955, by Emsco Manufacturing, manufacturer of oil-country drilling and pumping machinery and equipment. The sales engineering staff of Johnston will be increased substantially, and the dealer organization greatly expanded to service customers throughout the United States and foreign countries.

Miller started with Emsco in 1929 and moved up in the organization in various capacities. He is vice president, secretary, and treasurer of Emsco, and general manager of Johnston Pump Co.

American Sand-Banum Moves

The relocation of its executive offices from New York City to the Meadow Brook National Bank Building in Freeport, N. Y., has been announced by the officers of American Sand-Banum Co., Inc.

New Quarters For Otis' New Iberia Division

Otis Pressure Control, Inc., has opened a newly remodeled warehouse and office building in New Iberia, La., as a part of the company's general expansion plans in Louisiana and in South, East, and West Texas and at its home office and manufacturing plant in Dallas.

Otis manufactures and markets a line of special subsurface controls for oil and gas wells and also operates a fleet of special wire-line service units in the industry. The firm is in its twenty-seventh year and has branch offices in all major producing areas in the Mid-Continent and Gulf Coast regions.

Bill Hill, division manager in charge

This is the new office and warehouse for Otis Pressure in New Iberia. The company has maintained a branch in New Iberia since 1939.

Avoid struggling starts and overloaded circuits...

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Capacitor Motors . . . ⅛ to 20 H.P. provide high starting torque, very high pull-up torque and require normal starting current. They are available in drip proof, splash proof, dust proof and explosion proof enclosures.

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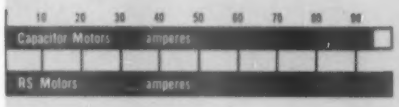
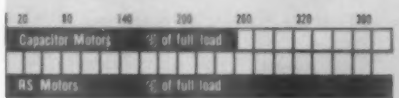
WHATEVER YOUR MOTOR JOB . . . there's a Century Motor Performance-Rated to handle it with top effectiveness. Contact your nearby Century branch office or Authorized Distributor.

TYPICAL OPERATING CHARACTERISTICS

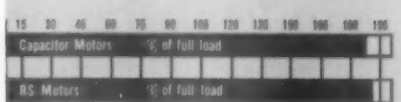
STARTING CURRENT
(High current may cause circuit overloading)



STARTING TORQUE
(available to start the load)



PULL-UP TORQUE
(available to bring the load up to speed)



Repulsion Start, Induction Motors (type RS) . . . from ½ to 7½ H.P. provide very high starting and pull-up torque, yet require unusually low starting current. They are available in drip proof and splash proof enclosures.

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Microwave radio handles communications for the Michigan-Wisconsin pipeline which carries natural gas from Texas fields throughout Wisconsin and Michigan.

Of the 60 repeater stations in the system, 53 are unattended and are equipped with Onan Standby Electric Plants and Onan Automatic Line Transfer Controls. When commercial power is interrupted, the Onan plants start automatically and supply power for operating microwave equipment.

Most of the Onan units are Model 305CK electric plants of 3,500-watt capacity. This model, together with the Onan 5 and 10KW "CW" electric plants have built-in advantages for microwave standby service. They are air-cooled, extremely compact, and dependable.

If you have a problem in standby power, write our sales engineers. Onan builds electric plants for every need . . . from 400 to 100,000 watts.

Onan Model 305CK shown installed in the repeater station at Waukesha, Wisconsin. Bottled gas is used for fuel.

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This new control facilitates testing of all control components as well as the engine generator set. Momentary contact switch transfers load from commercial power to the generating plant with only 1/10th second interruption. Generator can be exercised by itself if desired. Control incorporates time-delay starting, stopping. Voltage sensitive relays, both on the commercial line and on generator output, assure correct voltage before transferring load.

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of the New Iberia division, said that the company is working 24 wire-line and service-truck units out of New Iberia, Houma, Harvey, and Lake Charles, La., and Brookhaven, Miss., which are district offices under New Iberia.

H. C. Otis, Jr., Dallas, executive vice president, said that the company had experienced a 30 per cent increase in personnel and service units last year. The manufacturing facilities and offices in Dallas are being doubled by a building program now under way.

Every Is Cummins' Assistant General Sales Manager

P. J. EVERY

Paul J. Every has been named assistant general sales manager, Cummins Engine Co., Inc., Columbus, Ind.

In announcing the appointment of Every to this newly created position, C. R. Boll, Cummins' general sales manager, stated that this is another step in the strengthening and expansion of the Cummins sales organization.

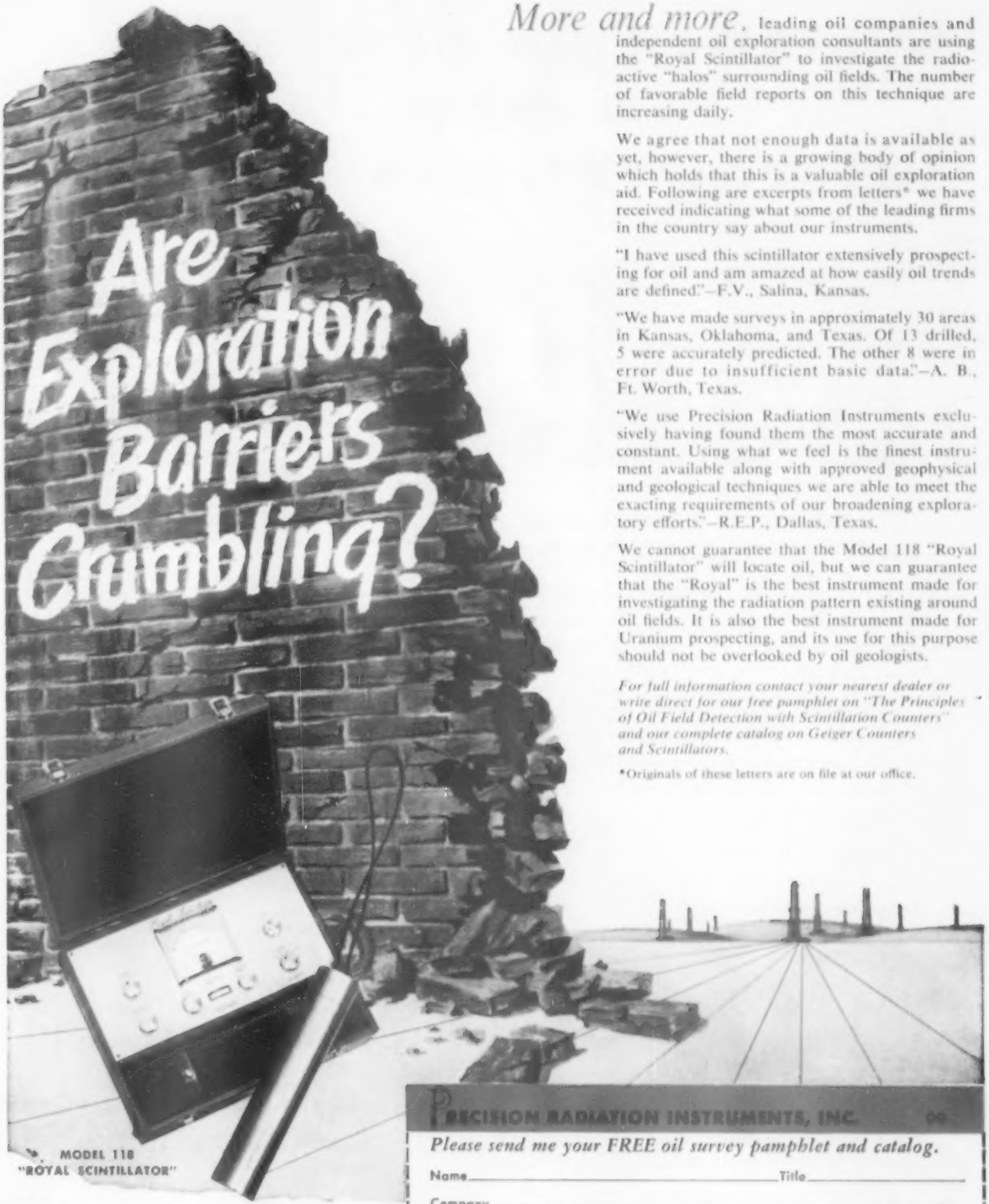
Every has been associated with Cummins since 1947, and, as manager of regions, was in charge of the operation of the 12 domestic Cummins regional offices, and the handling of domestic distributor activities. For the past 2 years, he has been responsible for the world-wide activities of Cummins Diesel Export Corp.

Before joining Cummins, Every was sales manager of the heavy-equipment division of Baldwin Locomotive Works, now a part of Baldwin-Lima-Hamilton Corp.

Baash-Ross Names Mays District Sales Manager

Baash-Ross Tool Co., division of Joy Manufacturing Co., has announced the promotion of Craig Mays to district sales manager of the Permian Basin, with headquarters at the Baash-Ross manufacturing and service plant in Odessa, Tex.

Mays has had a wide experience in various field operations, not only since joining the Baash-Ross organization in 1948, but also through his previous connections with such companies as Independent Eastern Torpedo Co., Richardson-Bass Oil Co., Magnolia Petroleum



More and more, leading oil companies and independent oil exploration consultants are using the "Royal Scintillator" to investigate the radioactive "halos" surrounding oil fields. The number of favorable field reports on this technique are increasing daily.

We agree that not enough data is available as yet, however, there is a growing body of opinion which holds that this is a valuable oil exploration aid. Following are excerpts from letters* we have received indicating what some of the leading firms in the country say about our instruments.

"I have used this scintillator extensively prospecting for oil and am amazed at how easily oil trends are defined."—F.V., Salina, Kansas.

"We have made surveys in approximately 30 areas in Kansas, Oklahoma, and Texas. Of 13 drilled, 5 were accurately predicted. The other 8 were in error due to insufficient basic data."—A. B., Ft. Worth, Texas.

"We use Precision Radiation Instruments exclusively having found them the most accurate and constant. Using what we feel is the finest instrument available along with approved geophysical and geological techniques we are able to meet the exacting requirements of our broadening exploratory efforts."—R.E.P., Dallas, Texas.

We cannot guarantee that the Model 118 "Royal Scintillator" will locate oil, but we can guarantee that the "Royal" is the best instrument made for investigating the radiation pattern existing around oil fields. It is also the best instrument made for Uranium prospecting, and its use for this purpose should not be overlooked by oil geologists.

For full information contact your nearest dealer or write direct for our free pamphlet on "The Principles of Oil Field Detection with Scintillation Counters" and our complete catalog on Geiger Counters and Scintillators.

*Originals of these letters are on file at our office.

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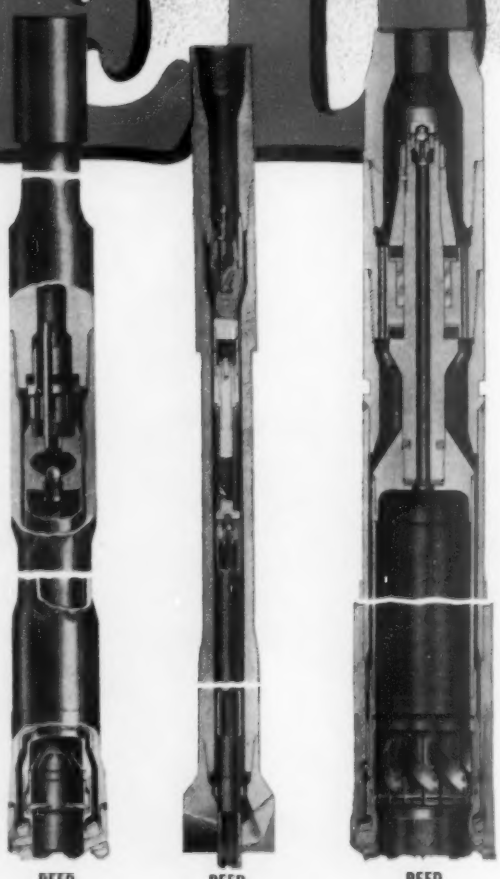
REED

THESE **REED CORE DRILL** FEATURES ASSURE YOU OF A HIGH PERCENTAGE RECOVERY

The Reed Kor-King and "SK" Core Drills feature a non-rotating inner barrel operating against trouble-free, oil proof, slush-lubricated bearings.

The Reed "BR" Wire Line Core Drill has the exclusive protrusion regulator spring which regulates the inner barrel. Protrusion of the barrel in soft formations and retraction of the barrel in hard formations assure maximum recovery of clean, unbroken cores.

Write, or see your nearest Reed salesman for further information.



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GOOD CORES

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1. REED Kor-King for conventional type coring
2. REED "SK" for frangible formations
3. REED "BR" Wire Line for continuous or intermittent coring in all formations

REED ROLLER BIT COMPANY

HOUSTON 1, TEXAS

Gulf Coast, Mid-Continent, Rocky Mountain and Canadian Distributor for Martin-Decker Products

Co., and with various drilling contractors.

In his new duties Mays will have charge of all Baash-Ross sales operations in the West Texas and New Mexico areas.

Brown-Strauss Completes Reorganization Plans

H. B. STRAUSS

N. B. KAHN

N. STRAUSS

Harry B. Strauss, president of Brown-Strauss Corp., has announced the recent election of Norman B. Kahn as vice president and treasurer of the company. Kahn is an authority in pipe and steel warehousing and merchandising.

Also Norman Strauss has been elected secretary of the corporation. Strauss, who has been with the company since 1947, has been active primarily with the liquidation of oil refineries, pipelines, and various industrial projects.

Harry B. Strauss, one of the founders, remains as president of the corporation and will supervise management.

All the above officers were elected to the board of directors of the corporation.

Chanute Refining Co., Chanute, Kans., an affiliate of Brown-Strauss Corp., has elected the following to the board of directors and officers: Norman Strauss, president; Harry B. Strauss, treasurer; and Norman B. Kahn, vice president. The company processes crude-oil bottoms from the oil fields of the Southwest.

Sun Oil Licenses Fielden To Make, Sell Developments

Licensing arrangements have been entered into between Sun Oil Co. and Fielden Instrument Division, Robertshaw-Fulton Controls Co., according to a joint announcement.

The agreement permits the manufacture and sale by Fielden of electronic devices used to control the levels in processing of petroleum products. Such devices have been operating successfully in Sun Oil's Marcus Hook refin-

Humble RUST-BANS *will save you money*

Check this list carefully.

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For priming all types of vessels and structures
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ery at Delaware, Pa. Fielden expects to begin production of the new line at once.

Franklin Supply Opens Store In Morgan City

LEE CROGER

Franklin Supply Co. has opened a new store in Morgan City, La., according to Jene Harper, president, Chicago.

Lee Croger has been appointed store manager. Croger was formerly store manager at Franklin's East Chicago and Grayville, Ind., store.

The Morgan City store will operate under the Gulf Coast district, headed by Ed Farrell, district manager, Houston.

Delta Tank Expands Sales Organization

R. B. BAZE

The appointment of Ross B. Baze, former executive of Black, Sivalls & Bryson, Inc., as sales manager of Delta's oil-field equipment and special order products division, and Russell A. Gasal, former executive of Butler Manufacturing Co., Kansas City, Mo., as general manager of Delta's Beardstown, Ill., plant, has been announced by Hal S. Phillips, president of Delta Tank Manufacturing Co., Inc.

At the same time, Phillips announced that John T. Nesser, former manager of the Beardstown facility, has been named sales manager of the firm's liquefied petroleum gas equipment division.

Delta, major subsidiary of General Gas Corp. and one of the largest manufacturers of storage tanks and cylinders for liquefied petroleum gas, recently began producing pressure vessels and other allied equipment for the oil field, chemical and petrochemical, and refining industries.

While with Black, Sivalls & Bryson, Baze served as United States and Canadian sales manager for the Climax Controls Division with headquarters in Tulsa, and also as West Coast sales manager for the B.S.&B. products with offices in Los Angeles. He earlier served as a member of the engineering staffs of both Warren Petroleum Corp. and Sinclair-Prairie Oil Co. During World

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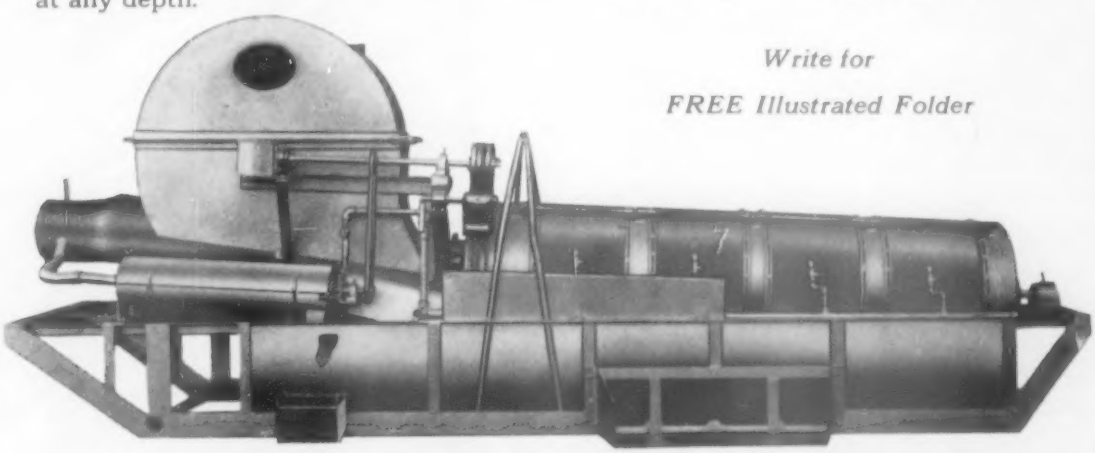

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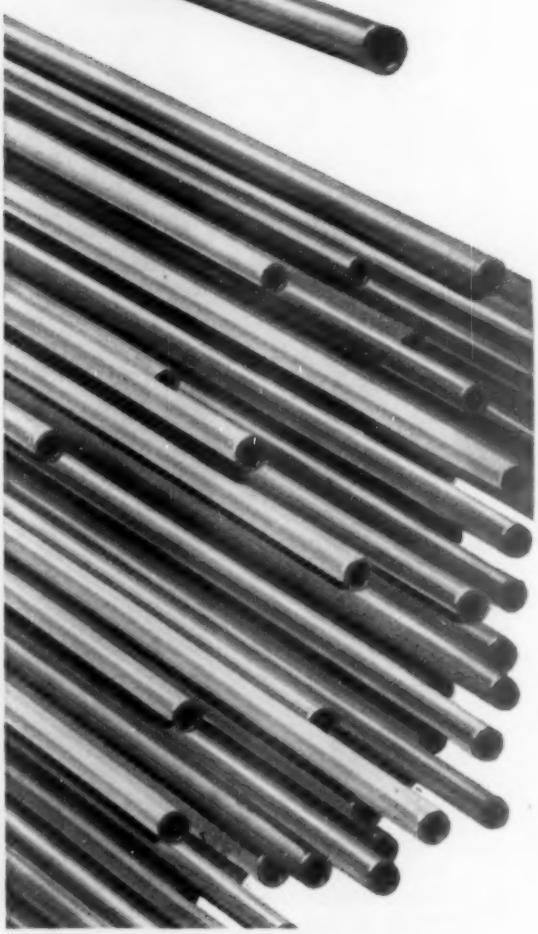
For more information on Chase Antimonial Admiralty, send for the free Chase Condenser and Heat Exchanger Tube Booklet.



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War II Baze was assigned overseas as assistant to the headquarters engineer in the Persian Gulf Command.

Gasal, a veteran of more than 20 years in the liquefied petroleum gas industry, joined Butler Manufacturing in 1933 after several years with Skelly Oil Co., and was instrumental in Butler's entry into the L.P.G. equipment field. He subsequently served as product and sales manager until joining Delta Tank in his new post as manager of the Beardstown plant.

Upflo Heater Destined For Formosan Refinery

On the first leg of its rail-sea-and-land trip to Formosa, this packaged Born Upflo heater unit is one of the two Upflo heaters manufactured by Born Engineering Co., Tulsa, destined for use in a catalytic reforming unit at the Chinese Petroleum Co.

Duff-Norton Purchases Coffing Hoist Co.

Duff-Norton Manufacturing Co., Pittsburgh, has purchased Coffing Hoist Co. Danville, Ill., and will operate the firm in the future as the Coffing Hoist Division of Duff-Norton Co.

Duff-Norton manufactures lifting jacks and a large line of ratchet, hydraulic, air-motor and worm-gear jacks. Coffing produces a wide variety of hand and electric-operated hoists and allied products.

Duff-Norton is changing its name from Duff-Norton Manufacturing Co. to Duff-Norton Co. in the interest of brevity and clarity.

President Walter I. Floyd of Duff-Norton stated that the acquisition of this leading producer of hoists is an important part of Duff-Norton's diversification and expansion program. The move gives both companies an entry into a much larger segment of the lifting equipment field.

Operations and personnel will continue unchanged at the Coffing plant, except that Frederick W. Coffing, president and cofounder of the 26-year-old company, will retire. He will continue to be associated with the Coffing Hoist

THE Bullard-Burnham SAFETY HOOK

At last a 100% safe hook for every type of hoist and puller. The pushbutton safety gate automatically locks closed, yet opens instantly with a touch of the finger. The safety gate also acts as an indicator to warn operators if the hook is even slightly sprung. Bullard-Burnham hooks are available in sizes ½ - 16A.

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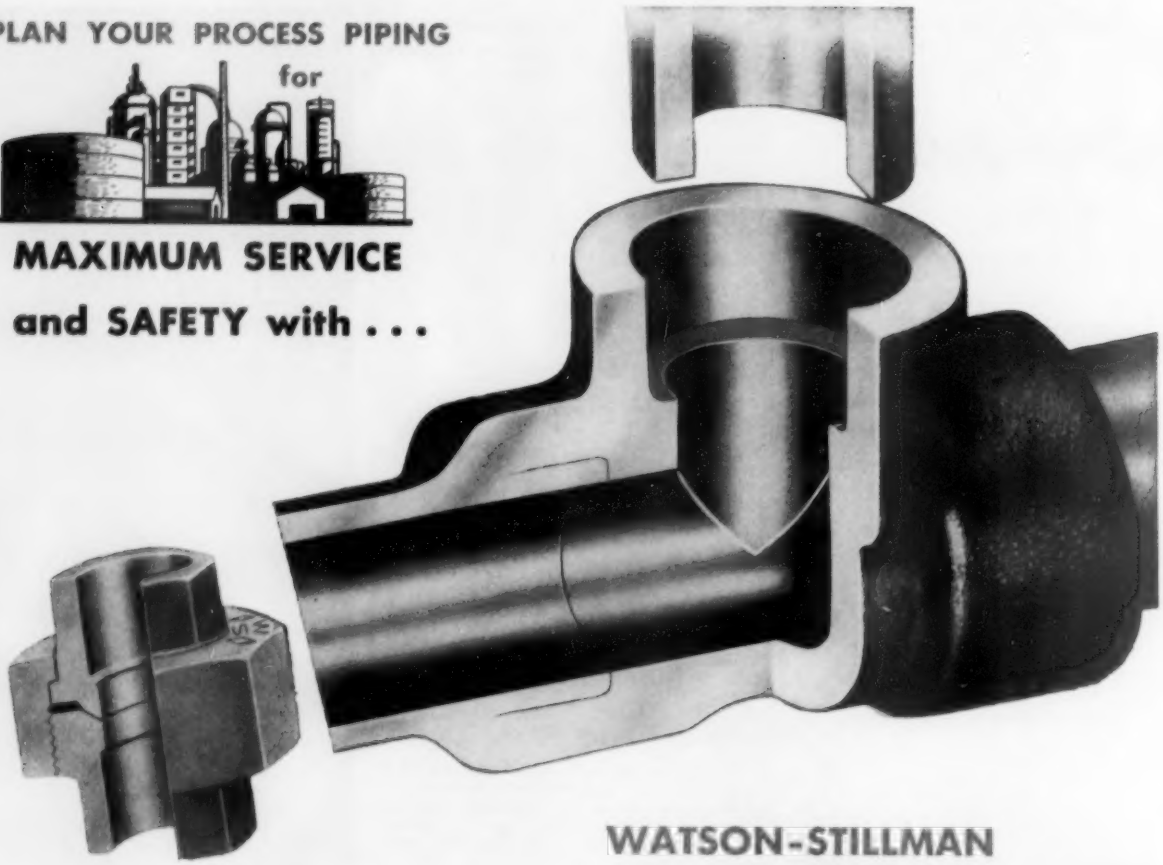

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FORGED STEEL FITTINGS

In high pressure steam lines...process liquid and gas piping...hydraulic fluid lines...wherever strong, tough pipe joints are needed, Watson-Stillman Socket-Welding Fittings provide a safety factor against costly piping failures. Drop-forged of high quality steel, they readily resist pressure, heat, corrosion, shock and vibration.

W-S Socket-Welding Fittings are easy to install. Deep sockets support and align the pipe for welding. No need for tack welding or special fixtures. And the outside-the-pipe fillet weld prevents welding icicles inside the pipe.

Watson-Stillman Forged Steel Fittings are available in carbon, stainless and alloy steel for Schedule 40, 80, 160 and XX pipe. Sizes ⅛" to 4". A complete line of forged screw-end fittings is also available.. Send today for Free catalogs.

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W-S WATSON-STILLMAN FITTINGS DIVISION

HKP H. K. PORTER COMPANY, INC.

Roselle, New Jersey 11

Division, however, as a consultant. Floyd will be president of the Coffing Hoist Division as well as president of Duff-Norton.

J. R. Coffing, who has been vice president, sales, for Coffing Hoist; J. F. Bookwalter, vice president, manufacturing; and George Buck, secretary-treasurer, will continue to direct the affairs of the Coffing Hoist Division as a management committee.

Harry Litwin Forms Engineering Company

Formation of Litwin Engineering Co., Wichita, Kans., an organization to design and construct refineries, gasoline, and petrochemical plants, has recently been announced by Harry Litwin, president of the new company.

Litwin is well known in the petroleum industry. He was associated from 1930 until recently with Winkler-Koch and later was vice president of Koch Engineering Co. During the last several years, Litwin has spent considerable time in European countries, managing the construction of refinery installations. He is also vice president and a director of Century Refining Co., Inc., Garden City, Kans.

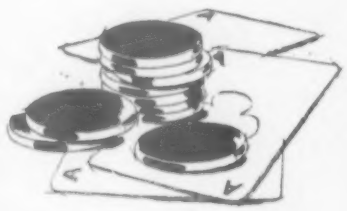
Cott Moved to Pittsburgh By Midwestern Pipeline

Norris E. Cott until now, purchasing agent and sales coordinator for Midwestern Engine & Equipment Co., Inc., was recently transferred to Pittsburgh to take over sales in the Northeast division comprising 17 northeastern states and two Canadian provinces.

Cott's official position will be manager of the Northwestern division of Midwestern Pipeline Products Co., which has recently acquired its own identity after several years as a division of Midwestern Engine & Equipment. Cott's experience in the pipeline industry plus his managerial background with Midwestern makes him the logical choice for the planned expansion of the northeastern territory.

Midwestern has pioneered many of the anticorrosion products which are now accepted throughout the pipeline industry, and much of Cott's time has been spent in pioneering and develop-

When the



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A completely new standard of octane quality is now available to all refiners thru REXFORMING† — a development that employs an entirely new concept in producing gasolines with clear octanes in excess of 100. And REXFORMING does this economically and continuously without limitations as to type of crude processed in the refinery.

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If you use gages it will pay you to investigate HELICOID performance records. There is a HELICOID long-life gage to meet every type of pressure indicating requirement. Ranges are to 20,000 p.s.i. and vacuum or compound.

Wall or stem mounting cases—flush panel or flangeless cases.

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ing new techniques and products in the field.

Cott joined Midwestern in the spring of 1953, having come to Tulsa following several years with Keystone Asphalt Products Co., and with related industries in the Southwest.

Oilwell Announces Three Changes In Eastern Area

W. G. SMITH

C. H. Maynard, eastern area manager of U.S. Steel's Oil Well Supply Division, has announced the following appointments: William G. Smith, Jr., has been named assistant district manager at Olney, Ill.; Warren L. Shafer became district representative at Bridgeport, Ill.; and M. L. Childress has been appointed district representative at Carmi, Ill.

Smith entered the employ of Oilwell in 1946 at the division's Carmi store.

W. L. SHAFER

M. L. CHILDRESS

In 1948 he was appointed store manager at this location and held this position until his present appointment.

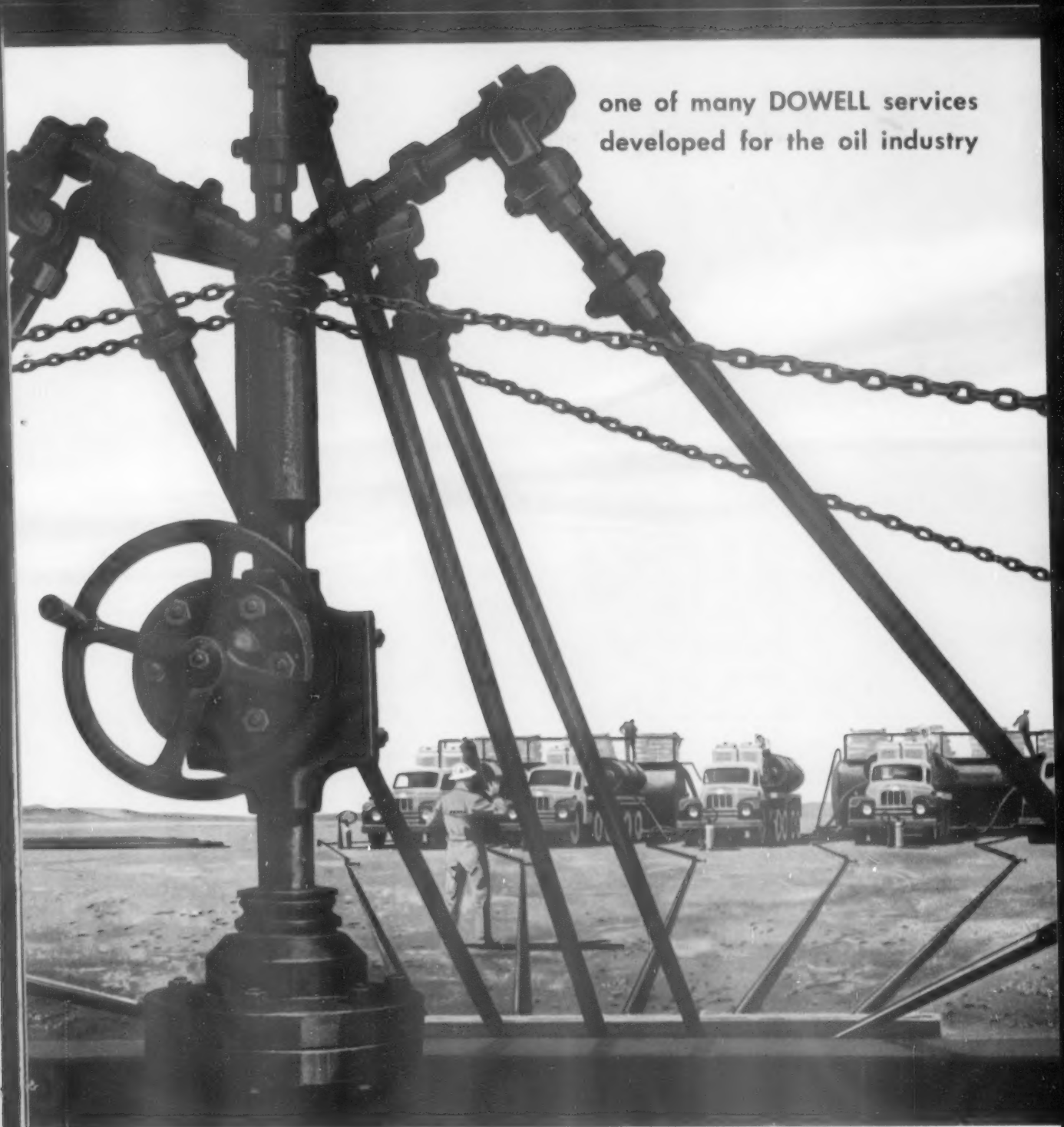
Shafer was employed by Oilwell in 1954 as an engineer trainee in the Illinois district, a position he held until his recent promotion.

Childress joined Oilwell's Mount Carmel, Ill., store in 1952 and was located there until his present assignment.

Baldridge Is Made Frontier Sales Representative

Promotion of Harry E. Baldridge to sales representative of Frontier Chemical Co., division of Union Chemical & Materials Corp., Wichita, Kans., has been announced by M. E. Clark, vice president, marketing.

Baldridge's territory will comprise Kansas, Oklahoma, Arkansas and Louisiana. He joined the Frontier organization in August 1952 as chief chemist of the Wichita plant. The company is currently producing caustic soda, chlorine, muriatic acid, benzene hexachloride, and oil-well and industrial salt in



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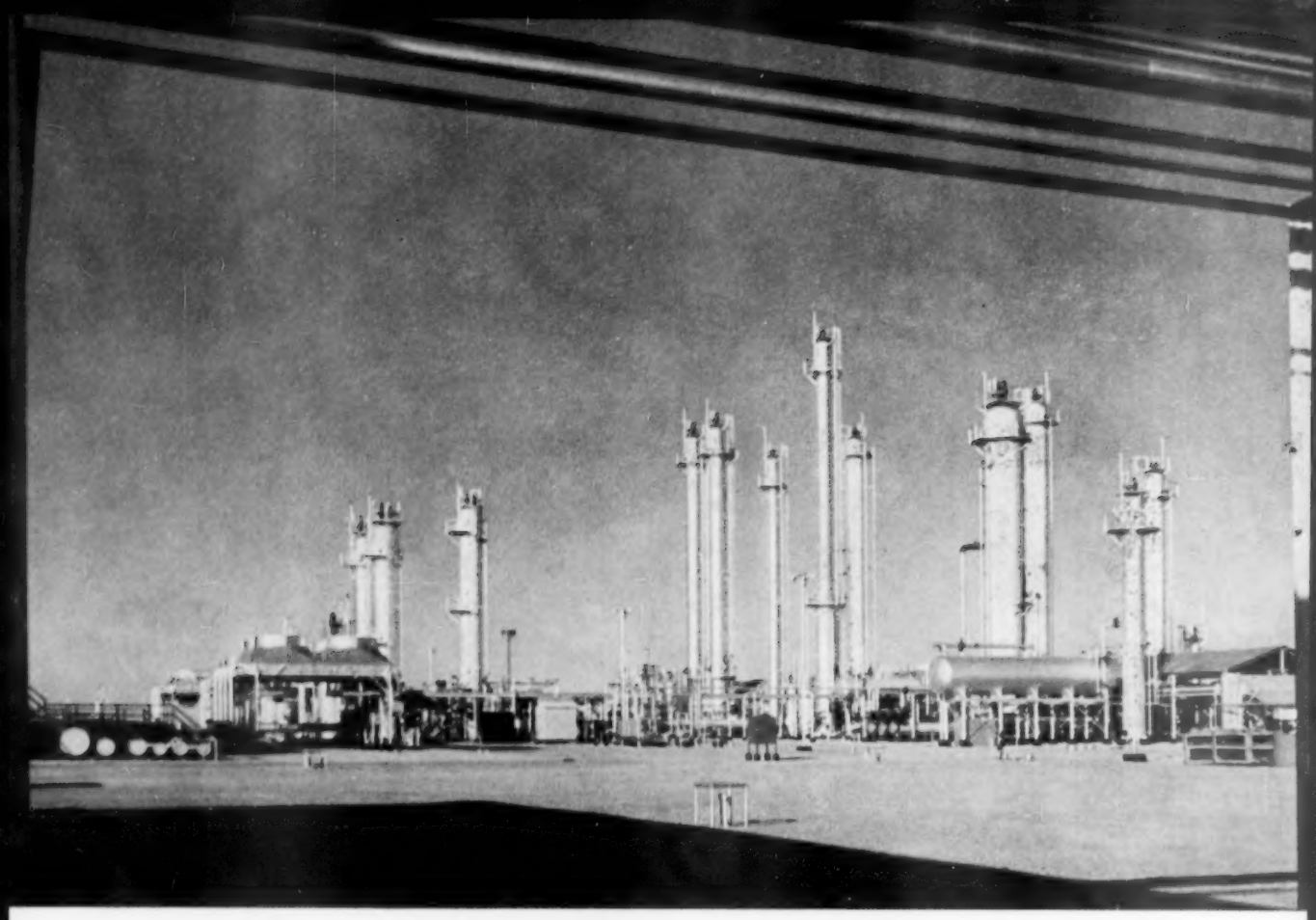

THE *Pegasus* GASOLINE PLANT

In the Pegasus field near Midland in West Texas HUDSON has completed the latest of SEVEN MAJOR PROJECTS for Magnolia Petroleum Company. These seven projects plus numerous smaller ones for the same client are typical of the work that has built the world-wide confidence of the oil industry in the ability of HUDSON to complete small or large processing plants in minimum time, with assured performance, and with minimum capital outlay consistent with low operating costs.

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bulk and briquette form. Principal plants are at Wichita, and Denver City, Tex.

Smith to Manage Joy's Dallas District Office

DARRELL SMITH

Joy Manufacturing Co., Pittsburgh, has announced the appointment of Darrell Smith as manager of the Dallas district office, to succeed J. A. Noyes, retired.

With Joy or a predecessor company since 1923, Smith has been associated with the sales organization since the early 30s. He was appointed district manager of the Knoxville, Tenn., office in 1937, and manager of the Southeastern division in 1947.

Since 1950 Smith has been based at the Pittsburgh home office as manager of distributor sales, which position involved coordinating the activities of Joy's nationwide organization of construction-equipment distributors.

Joy's Dallas office is headquarters for an area covering Oklahoma, Louisiana, and all Texas except several western counties.

McCullough Names Ottinger, McClanahan To New Posts

The appointment of N. H. Ottinger to the recently created position of division logging engineer for McCullough

N. H. OTTINGER

McCLANAHAN

Tool Co.'s mountain division and the opening of a new service branch at Baker, Mont., have been announced by I. J. McCullough, president of McCullough Tool. The company will provide radiation logging, bullet and jet perforating, and all types of wire-line and fishing-tool services from this new location.

Ottinger had been employed by Schlumberger Well Surveying Corp. for 16 years, attaining the position of district manager of its Gulf Coast and Mid-Continent districts. He then joined Sinclair Oil & Gas Co. as senior geophysicist being responsible for analysis of all electric and radiation logs in

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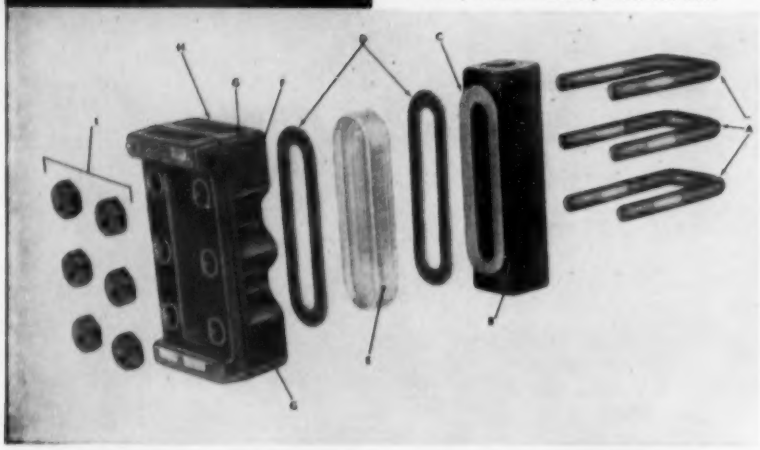
G Extra heavy beam at end of Frame (prevents distortion when bolts are tightened to meet high pressure service)
H Frame overlaps liquid chamber at all points — provides full backing for the gasket preventing blow-outs
I Alloy Steel accurately threaded nuts



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Designed for temperatures ranging from sub-zero to over 1000°F. and for test pressures exceeding 15,000 psi., Penberthy gages are used extensively for liquids ranging from water to highly corrosive and dangerous chemicals.

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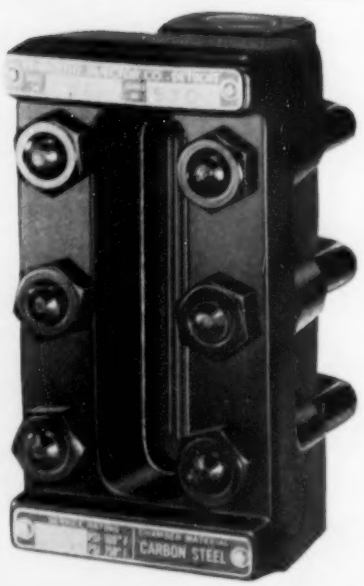

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- ELECTRIC SUMP PUMPS
- CYCLING JET PUMPS
- INJECTORS

wells drilled by Sinclair. In his new capacity Ottinger will cover all of McCullough's mountain division, which encompasses Colorado, Montana, North and South Dakota, Utah, Wyoming, and Nebraska.

R. D. McClanahan has been transferred from McCullough's Williston, N. D., branch to serve as branch manager of the new service location at Baker. McClanahan has had over 10 years of oil-field experience in Wyoming and Montana. His experience includes 2 years with Union Oil Co. at Cut Bank, Mont., and over 2 years in the field with McCullough Tool prior to his recent appointment.

The new Baker location brings to 53 the total sales and service locations of McCullough Tool in the United States and Canada.

Penn Salt Of Washington Names New Vice President

E. H. KARR

Appointment of Errol H. Karr to the position of vice president, Pennsylvania Salt Manufacturing Co., Washington, has been announced recently by Fred C. Shanaman, president.

Karr, formerly manager, technical development, served in several technical and administrative capacities during his 20 years with Penn Salt. From Yakima, Wash., Karr started his Penn Salt career in the experimental field of agricultural chemicals. He later served Penn Salt's western subsidiary in such capacities as chief chemist, superintendent, Portland, Ore., plant, technical supervisor and manager of agricultural chemicals.

Portadrill Names McGann As Sales Engineer

R. J. (Bob) McGann, widely known seismograph and drilling contractor, has been appointed sales engineer for the Portadrill Division of Winter-Weiss Co., Henry A. Winter, Jr., general manager of the firm, has announced recently.

McGann was associated with Western Geophysical Co. from 1937 until 1946 when he became an independent drilling contractor operating in the mountain region. In 1948 he moved his operations to Canada where he engaged in contract seismic and core-hole work in northern Alberta. His experience with Portadrill on various drilling and exploratory work was instrumental in his appointment with the Portadrill organization.

to all NATURAL GASOLINE MEN

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from the

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Cooling Tower Service, Div.—Santa Fe Tank and Tower Co. of Texas
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Joseph A. Coy Company, Inc.
Crane Packing Company
W. H. Curtin and Company
Dallas Tank Company, Inc.
Daniel Orifice Fitting Company
Davison Chemical Co.
Davis Regulator Company
Dearborn Chemical Company
De Laval Steam Turbine Company
Delta Engineering Corp.
M. H. Detrick Company
Dresser Engineering Company
E. I. du Pont de Nemours and Co., Inc.
Eggelhof Engineers
John W. Elder Company
Elliott Company
Engine Life Products Corp.
Engineering Equipment Co.
Engineers and Fabricators, Inc.
Ethyl Corporation
The Fisher Governor Company
Flint Steel Corporation
Flow Measurement Co.
The Fluor Corp. Ltd.
The Foxboro Company
France Packing Company
Franklin Supply Company
The Garlock Packing Company
Gasoline Plant Construction Corp.
General Electric Co.
J. B. Gill Company
Goulds Pumps, Inc.
Graver Tank & Mfg. Co., Inc.
Greene Brothers, Inc.
The Griscom-Russell Co.
Grove Valve & Regulator Co.
D. W. Haering and Co., Inc.
The Happy Company
Hercules-Lupfer Engine Sales Co.
The Hilliard Corporation
Hudson Engineering Corp.
Huffman & Pierce Construction Co.
Industrial Scientific, Inc.
Infilco, Inc.
Ingersoll-Rand Co.
Johns-Manville Sales Corp.
Kansas Paint and Color Company
The M. W. Kellogg Company
The Koch Engineering Co.
James S. Kone & Company
Ladish Company
Le Roi Company
Warner Lewis Company
A. M. Lockett and Co., Ltd.
The Lubricosos Specialties Mfg. Co.
The Lunkenheimer Co.
Maintenance Engineering Corp.
F. H. Maloney Company
Manco Engineering Co.
Manning, Maxwell and Moore
Manzel
Steve C. Maples Div., Allan Edwards Mfg. Co., Inc.
Market Development Div.—Phillips Petroleum Co.
The Marley Company, Inc.
Chas. Martin & Company
Marsh Instrument & Valve Co.
C. A. Mathey Machine Works
Lynn McGuffy Company
J. R. Meek Company
Metal Goods Corporation
Mid-Continent Supply Company
Minneapolis-Honeywell Regulator Co.
Moorlane Company
Moran Furnace and Sheet Metal Co.
National Petroleum News
The National Supply Company
National Tank Company
Naylor Pipe Company
Nickles Machine Co.
Nordstrom Valve Div.—Rockwell Mfg. Co.
Wm. W. Nugent & Co., Inc.
Nutter Engineering Co.
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The Oil Daily
Oil Well Supply Div.—U. S. Steel Corp.
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Orbit Valve Company
Pacific Pumps, Inc.
Paramount Supply Co.
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Petroleum Processing
Petroleum Refiner
Pittsburgh Equitable Meter Div.—Rockwell Mfg. Co.
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Puffer-Sweiven Company
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Stentz Equipment Co.
Stitt Ignition Co.
Superior Mfg. Co.
Taylor Forge and Pipe Works
Taylor Instrument Companies
Tellepsen Construction Co.
The Tennant Co.
Tube Turns Div.—National Cylinder Gas Co.
Tuloma Builders, Inc.
Tyler-Dawson Supply Co.
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Vinson Supply Company
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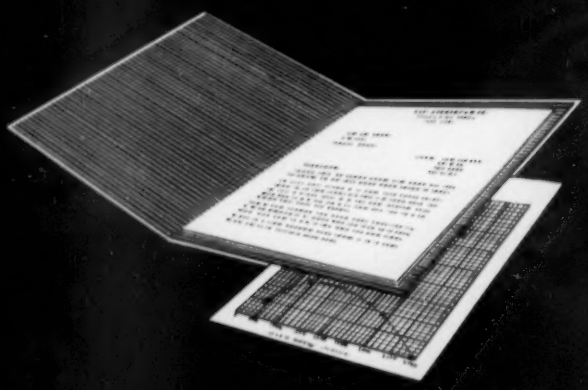
Walco Engineering & Constr. Co.
Walworth Company
Well Equipment Mfg. Corp.
Westcott & Greis, Inc.
Western Chemical Co., of Kansas City, Mo.
Western Chemical & Supply Co.
Western Supply Co.
The Wickes Boiler Co.
Woobank Machinery Co.
World Petroleum
Worthington Corp.
Wright Chemical Corp.
Wyatt Metal and Boiler Works
Young Sales Corp.
John Zink Burner Company



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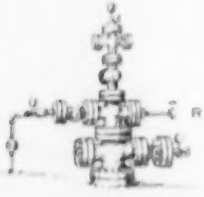

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EXPLORATION

Return to the Rocks

by Frank J. Gardner

IF this exploration number of the Journal seems heavier than usual, it's probably due to a weighty uranium content. We decided it was time to look into the reported uranium activities by oil operators over the country. The results of that survey can be found starting on page 96. Three other papers in the exploration section reveal the techniques used in the U-search, and it is in these that geologists and geophysicists may find some potent truths about the future of their professions. It appears that they have bright prospects ahead of them, but to make the most of this cheerful outlook, some changes must be made.

One of the most intriguing statements in this issue points to a new "back to the rocks" trend—the return to hard-rock geology. Professors all over the nation report a vigorous new interest and new elective students in mineralogy, petrology, and sedimentation courses. They attribute a lot of it to "the U-fever" that has swept the land.

The road to success . . . It's about time for this return to the rocks. For too long, our geology graduates have sought the easy way to oil finding via swivel chair and contour pen, when hammer and alidade might better have done the job. Preoccupied with map, log, and completion card, the subsurface geologist in his ardent quest for structure has leaned further and further away from the old basic tenets of earth processes. His imagination has been dulled by dogma, precedent, and prejudice. He lives in a world of office drudgery, buried in papers, plans, and protocol. He offices with tedium . . . and I.B.M. machines.

But the road to success in oil finding still must lie "up the canyon and over the ridge, in unknown regions and uncharted spaces." This country needs that success. It's going to need more and more oil . . . and more and more uranium. The earliest date now set for nuclear fuels to begin carrying a measurable amount of our energy needs is 1970. According to the gloomy reserve figures just released by the A.P.I., the need for oil will never be met by present supplies, even to that date. Uranium poses no threat to petroleum, for if we are to believe the Putnam report, there'll never be enough of either.

In unknown regions . . . So we need more oil. Where are we going to find it? We often hear it said that all the big structures have been found. Have they? There's plenty of room for doubt. Most of the hunt for uranium is taking place in unknown regions and uncharted spaces. It's being done with unorthodox instruments in the hands of unorthodox explorers. Levorsen has issued a call for these unorthodox explorers in the hunt for oil. Should we be surprised, then, to see new and important surface structures uncovered in the course of this nuclear marathon? Most oil companies now view the discovery of uranium as a byproduct of the search for oil. But it also makes sense that the process should work in reverse. Even a modest-sized oil field is considered a more valuable property than the most prolific uranium mine yet discovered. Witness the number of uranium companies that add "& Oil Co." to their names every day.

Oil companies are accustomed to exploration couched in terms of several square miles. Uranium lodes are measured in feet. The difference is one of dimension, not technique. Uranium hunting is largely a problem of sedimentation, and such problems lie within the realm of the petroleum geologist rather than the hard-rock mining engineer. The oil hunter has only to modify his thinking to make the adjustment from petroleum to uranium. He uses the same tools, but he must progress from the general to the particular. Elsewhere in this issue of the Journal, Levorsen describes the phases of discovery within a petroleum province. They progress from the large-structure search to the combined structure-stratigraphic search to a final phase of pure strat search.

In many of the present producing oil provinces, geologists find themselves in the final phase. Geophysicists are in the same boat. In these areas, the pursuit of oil is narrowing to ever smaller uplifts and to the buried strat traps. They are progressing from the general to the particular.

And virgin areas . . . But what of the virgin provinces, untested for economic or geographic reasons? With the enormous demand for oil that lies ahead, mustn't we expect them to **become** economic? Who knows what secrets lie hidden below the Great basin of Arizona, Nevada, Utah, and Idaho? The riddle of the subsurface in the Pacific Northwest is a challenge to any thinking oil finder. No oil on the east side of the Appalachians? There are those who think there might be. There are plenty of large anticlines known and mapped, but untested, on the western side of the Rockies. The Mojave Desert has recorded oil and gas shows. The thrust belts on the eastern flanks of the Rockies, now attracting so much attention in Canada, are essentially untested in the United States. The Colorado Plateau, focal point of the uranium boom, is also a prime target for oil. As he carries his geiger counter over these virgin territories, the uranium prospector, if he is a geologist or geophysicist, cannot fail to lay the groundwork for new oil provinces.

Requires fundamentals . . . The ore search in these unknown areas is destined to pass through stages identical to those associated with oil—from direct surface evidences to indirect subsurface evidences. Most uranium deposits that have been found so far are at or near the surface; the time will come when there won't be any undiscovered surface deposits and the subsurface must be probed. That, too, will be a time for new discoveries of oil in unexpected places. The present emphasis in proved oil provinces is on stratigraphic search. To find strat traps, the geologist needs complete command of the basic fundamentals of sedimentation, tectonics, and mineralogy, plus a knowledge of fluid flow. He must examine sedimentary processes and percentage relationships as clues to oil movement and accumulation. To find uranium, he needs complete command of exactly the same fundamentals.

The return to the rocks had to come. It's essential to the finding of oil, and it's essential to the finding of ore. That the two activities are parallel is a happy circumstance for the future of geology and geophysics, for they hold the keys to both.

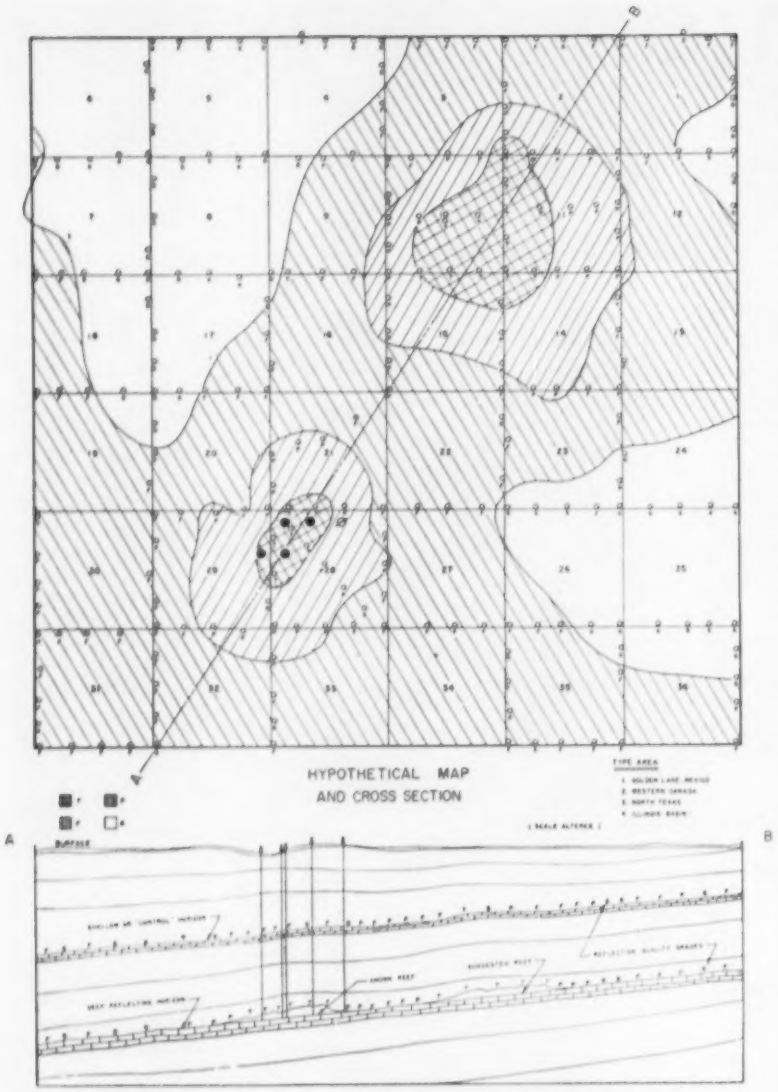


Fig. 1—Idealized cross-section showing effect of reef on reflection quality.

Here's the S.E.G.'s "Best Paper of 1954" . . .

Reflection Quality: A Fourth Dimension

by Ben F. Rummerfield

CERTAINLY experience has shown that oil fields can be found more readily where the quality of seismic work is good. Now let's explore the possibility that changes in the quality of deep reflections may add a fourth dimension to seismic interpretation.

In short, let's look at a detailed evaluation of the quality of individual reflections on single seimic records and their possible relation to oil finding.

The problem is whether or not information other than structural data can be derived from a study of seismograms. The elastic properties of the subsurface beds determine if satisfactory seismic data can be obtained. That is, satisfactory reflections can come from marker horizons that have a pronounced contrast in physical characteristics compared to adjacent geological strata.

Control factors . . . This suggests that we may have a tool to use in evaluating changes in the physical properties of a reflecting horizon. That tool is analysis of the quality of individual reflections.

The seismic and geological control factors essential to such an analysis (Fig. 1) are:

1. A good, consistent, shallow reflecting horizon must be present to be used as a "control horizon." This horizon is used for a quality comparison and to make sure that proper field techniques and instrumentation are being used.

2. A deeper reflecting horizon in a strategic location—and/or a potential reservoir — must be present. A pronounced change in the quality of this reflection, if the control reflection quality remains constant or nearly so, may indicate a change of physical characteristics within the reflecting horizon itself.

3. An even deeper reflection than the key horizon referred to above would be helpful. Such a horizon would also act as an additional control horizon for quality comparison.

A map can then be prepared showing the reflecting quality at each shot point for the strategic horizon. Any changes in quality not shared by the control horizon might be used to study variations of stratigraphy or lithology.

In doing this, personal feelings must not be allowed to influence the judgment of the interpreter in evaluating reflection quality.

The quality of a reflection depends upon its consistency and "character." But quality is also a visual evaluation by the interpreter of the individual reflection. It is wise to choose a typical record for each area and set up a standard quality grade for reflections so as to provide a common basis for comparison.

Examples . . . The diagrams which illustrate the method in this paper are simplified and hypothetical. But they approximate actual maps prepared by this method.

Fig. 1 is an idealized section similar to the Western Canadian geosyncline. The fact that we obtain fair-to-good re-

Author is vice president, Century Geophysical Corp., Tulsa.

The Society of Exploration Geophysicists selected "Reflection Quality, a Fourth Dimension" for their annual Best Paper award. The paper originally appeared in Geophysics, Vol. XIX, No. 4.

flections from the persistent shallow horizon assures us that our instrumentation and field technique are adequate for the area. Then we must try to qualify the deeper reflection.

The presence of a reef and accompanying changes in stratification and lithology have apparently resulted in a decay of the reflection coefficient of the deep horizon in the immediate zone of the reefing. And the shallow horizon, having undergone no change in physical characteristics, continues to serve as a satisfactory reflecting, or control, horizon.

The results are evaluated by contouring a map showing the quality of the reflections obtained from the deeper horizon at each shotpoint. In our idealized case, it would be feasible to associate an area of poor-to-questionable deep reflection quality with the presence of a possible reef.

Fig. 2 illustrates an idealized case where seismic reflection quality degenerates gradually from good to questionable to nonexistent. Such a possibility might occur where a stratigraphic pinchout, a structural unconformity, or an erosional surface is encountered.

Again, a shallower control horizon is assumed. Then, by mapping the quality of the reflection used for the deeper map, it is possible to study alignments which may be indicative of old shore lines or erosional surfaces. Thus, trends such as strand-line projections may be identified and valuable information may be obtained regarding subsurface structural and stratigraphic conditions.

Subsurface topograhy may be partially outlined by a quality map study. In one area (similar to the hyphothetical one shown in Fig. 3), the quality of individual deep reflections was mapped. It was found that the apparently erratic scattering of the questionable deep reflections resolved into a dendritic pattern thought to be related to a subsurface Mississippian topography. This information was very helpful, not only in placing possible reservoirs at the edge of the Mississippian escarpment but also in establishing the presence of porous sands which replaced the eroded Mississippian section.

A similar problem exists in some areas of Oklahoma where Hunton topography influences subsurface studies and may lead to pseudo-structures on seismic maps.

Fig. 4 shows a deep-seated faulted structure masked by an unconformity. An area of deep questionable reflections would be expected to coincide with the faulted anticlinal axis.

After considerable investigation and experience, it becomes apparent to the seismic interpreter that the particular

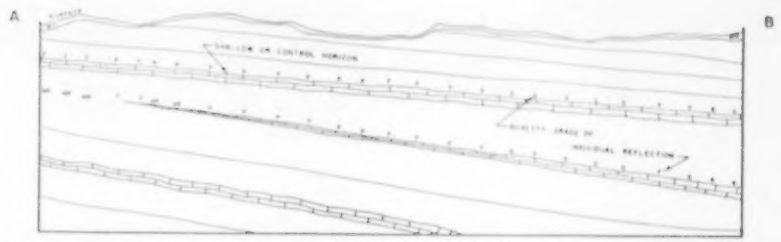


Fig. 2—Effect of pinchout on reflection quality. These data can be mapped to show pinchout.

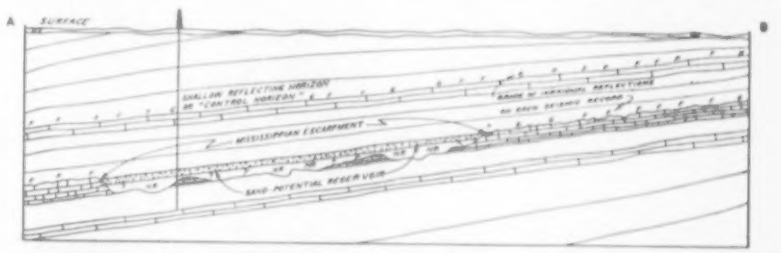
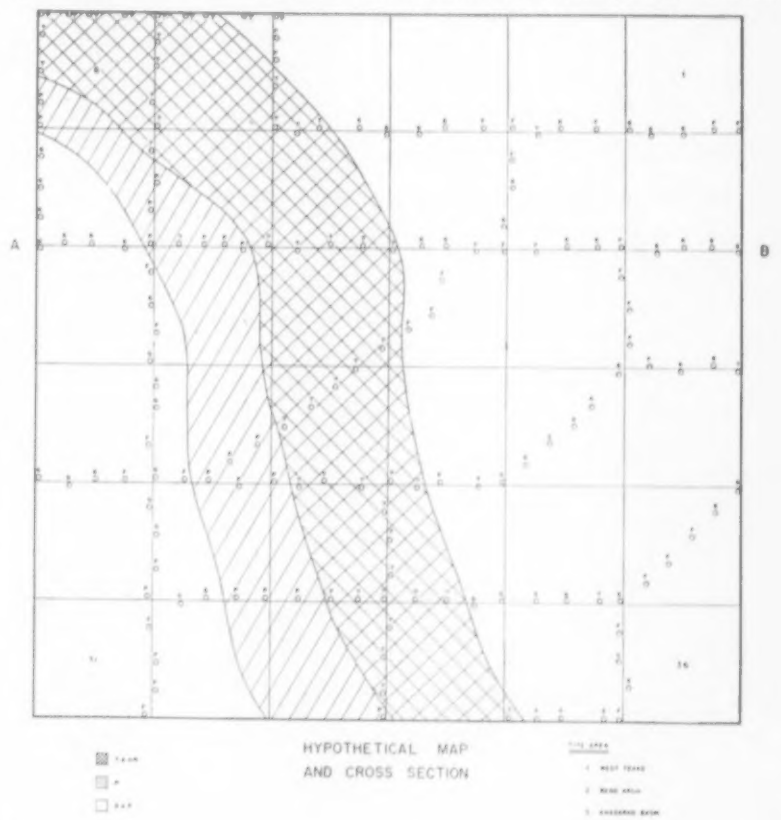


Fig. 3—Buried Mississippian topography is revealed by idealized reflection quality cross section.



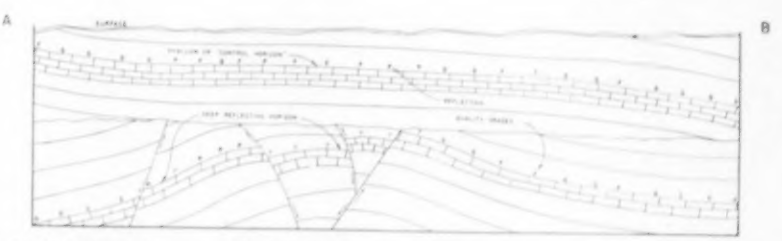


Fig. 4—Effect of deep-seated fault below an unconformity upon reflection quality as illustrated by a hypothetical quality map.

zone in which he is normally most interested is quite often the zone of poorest seismic reflections and the zone most difficult to interpret.

The first inclination is to write off this effect as "pure cussedness" and perversity of the seismic method. But as an interpreter continues to encounter this problem, he reaches the conclusion that there may be valid reasons for his dilemma.

For example we know that oil accumulates in structural areas which deviate from the normal. We also know that a simple plane acts as the best reflector and that the poorest reflections would be received from zones of maximum flexure. So if faulting were to occur in competent beds, the areas in which the faulting most likely would take place would be in the zones of maximum curvature where the beds are subjected to the greatest stress. Therefore, trends of structural axes and/or faulting might be outlined by seismic quality maps.

Applications . . . The preparation of quality maps in the average area is a very difficult undertaking. If the reflection is persistent and the quality change is random, the construction of such a map may be a waste of time. On the other hand, it has been found that after considerable study that the inconsistency itself of individual reflection quality in some areas may finally crystallize into a recognizable pattern.

The delineation of such data is not necessarily structural, and must be of a reconnaissance nature. At times the violation of one or several points may be advisable. Care must be taken that the patterns, under these circumstances, are not being forced to substantiate some preconceived idea of the interpreter.

The use and value of these maps are, to a very marked degree, dependent upon the imagination, ability, and experience not only of the interpreter but also of those in exploration management who must coordinate the general geological and geophysical data with all other knowledge of the area investigated. It cannot be overlooked that such studies impose a time-consuming, additional burden upon already overtaxed exploration personnel.

This approach may add a fourth dimension to normal seismic maps. It may also serve to illustrate that imagination, when controlled, is an exploration tool by which the geologist and the geophysicist can advance the effort to find oil. Further, **every** seismic record may become important from the viewpoint of evaluating oil possibilities, and not merely those records "on structure."

It has been estimated that the exploration industry spends only 10 per cent or less of total seismic costs on the analysis and interpretation of seismic data. The revision and reanalysis of work now existing in many exploration department files would undoubtedly bring to light many undiscovered oil fields. Such reanalysis might well prove to be the cheapest and most effective exploration work possible.

These facts spotlight the urgent need for additional interpretive talent and efforts. Until this need is fulfilled, the oil-finding effort of the industry will suffer, and potential deposits will continue to be overlooked.

Colleges Expand Geological Training

NUMBER OF PETROLEUM AND GEOLOGICAL ENGINEERING STUDENTS AS OF JANUARY 15, 1955

School—	Petroleum engineering			Geological engineering		
	Seniors	Juniors	Future	Seniors	Juniors	Future
University of California (Los Angeles)	10					
University of Minnesota	1	4	9	2	5	24
Texas College of Arts and Industries	22	36	158			
New Mexico School of Mines	4	6	20			
University of California (Berkeley)	7*-8	11	22			
Colorado School of Mines	24	41	156	50	42	187
University of Corpus Christi			20			
University of Houston	45	42	192			
University of Kansas	17	22	50	13	21	40
Louisiana Polytechnic Institute	10	14	127	3	3	33
Louisiana State University	66	74	250			
Montana School of Mines	10	10	97			
Oklahoma A. & M.	35	40	125			
University of Oklahoma	91	134	257	33	42	9
Pennsylvania State University	23	22	61			
University of Southern California	7	11	15			
Stanford University	9	9	7			
Texas A. & M.	65	85	269	54	58	83
Texas Technological College	33	44	245			
University of Texas	87	134	365			
University of Arizona				18	8	46
St. Louis University				1	2	20
South Dakota School of Mines & Tech.				11	11	44
University of Utah				7	14	27
Montana School of Mines				9	8	40
Michigan College of Mining & Tech.				10	21	39
Total	574	739	2,445	211	235	592

*Graduate.

THE table above illustrates the continued and increased interest in geology and petroleum engineering in the nation's schools. The column "Future" under both Petroleum and Geological Engineering indicates an increase in such students in the future semesters. In the years just after World War II the country's leading geology and petroleum engineering schools faced serious shortages in professors, laboratory facilities, classrooms, etc.

The ever-expanding oil industry has forced these various colleges to increase their facilities. The table denotes that Texas colleges still rank high in the number of geology and petroleum students. Oklahoma, Kansas, and Louisiana rank high, also. There is also an increase in students in geological engineering in most of the colleges.

Exploration Highlights

MID-CONTINENT

KANSAS

Operator to Test at Pawnee County Prospect

Pryor, Tracy, and D&M Drilling Co. will test oil shows at 1 Wurm, SW SW SW 32-23s-16w, Pawnee County Mississippi prospect.

A Mississippi drill-stem test at 4,255-4,300 ft. recovered 380 ft. of heavy oil and gas-cut mud and 90 ft. slightly oil and gas-cut mud. The well hit the Arbuckle at 4,550 ft. with no more shows reported. This Pawnee indicated strike is about 2 miles northwest of Edwards County's Enlow pool.

Nomenclature Labels Twelve New Kansas Discovery Areas

Names have been recommended for 12 new fields in Kansas by the Kansas Nomenclature Committee at its March meeting.

Southern Kansas . . . In Barber County E. H. Adair 1 Bloom, in the process of completion, is the discovery well of

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LOUISIANA: Shreveport, 3-1648 — Lake Charles, HE-9-4724 — Lafayette, 4-2396 — Houma, 2-2771 KANSAS: Great Bend, 4306 — Liberal, 4822
OKLAHOMA: Oklahoma City, CE-2-5342 — Pauls Valley, 1577 — Seminole, 2938 — Healdton, 77 — Ardmore, 857 — Perry, 313. NEW MEXICO: Hobbs, 3-2015.

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GERMANY—Atlas Deutsch-Amerikanische Olfelddienst G. m. b. H.; Kiel

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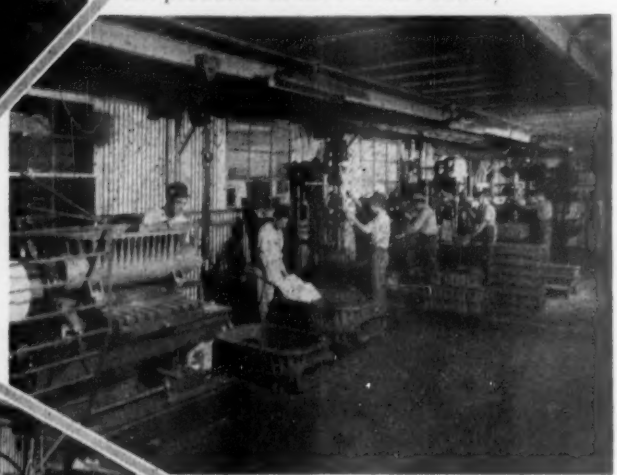
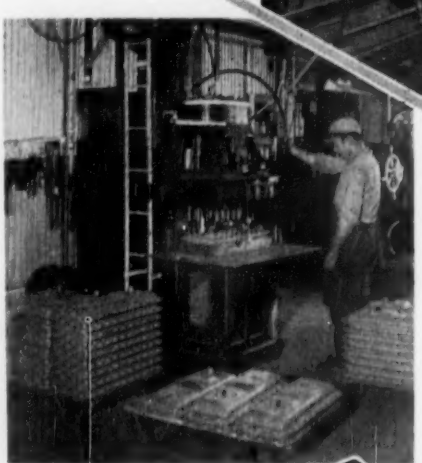
. . . see explosion-proof castings being processed in the NELSON "Box" Shop . . . . .

AMPLE STOCKS OF RAW CASTINGS: Enclosures for Nelson explosion-proof circuit breakers, motor starters and junction boxes are shown in storage yard awaiting machining. All castings are produced in the Nelson Foundry.

ALL FLANGE SURFACES RECEIVE TWO GRINDING OPERATIONS: Flanges and mounting feet of Nelson cast iron enclosures are given a rough-grind followed by a finish-grind, thus insuring a close tolerance and a smooth, machined surface.



DRILLING COVERS FOR MOTOR STARTERS: Photograph at right shows multiple spindle drill being used to drill covers for Nelson explosion-proof combination motor starters.



DRILLING CONDUIT OPENINGS AND MOUNTING FEET: Above photo shows the area of the Nelson Box Shop where conduit openings for breakers, starters, junction boxes and lighting panels are drilled and tapped; and where holes for flange bolts, mounting feet and mounting pans are drilled. Boxes are made ready for installation of controls and electrical assemblies.

No. 4 in a series of pictorial tours through the Nelson Plant showing Nelson Electrical Equipment "in the making".

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TULSA, OKLAHOMA

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Bloom pool, NE NE NW 23-32s-12w. The pay is the Simpson. Also in Barber, West Whelan pool was opened at Purcell-Mull 1 Kisling, SW SW NE 25-31s-12w. This discovery finaled for 83 bbl. of oil per day from the Mississippian.

In Cowley County, Brandenburg pool was opened at Aylward Drilling Co. 2 Brandenburg "A," SW SW NW 3-35s-3e, with production from the Mississippian.

Southwest Kansas . . . An important new pool was established in Kiowa County at Gulf Oil Corp. 1 Nichols, NE NE NW 20-29s-18w. This well, opening Nichols pool, completed for 7,218 M.c.f. of Mississippian gas.

Eastern Kansas . . . In Greenwood County an old well worked over was completed for 25 bbl. of oil per day from the Arbuckle, opening Salt Springs pool.

The discovery well was Bedell-Catt 1 Evans, SE SE SW 23-26s-12e.

Central Kansas uplift . . . In Barton County Thunderbird Drilling Co. is completing an Arbuckle discovery at 1 Kimpler, SE NW SE 31-18s-11w, to open Kimpler field.

In Ellis County East Irvin field opened at Thunderbird 1 Orth, NE NW NW 4-14s-19w. This well is completing in the Lansing lime. Also in Ellis, a Marmaton sand discovery is completing to open West Kraus pool. It is Coppinger Drilling Co.-Colorado Oil & Gas Co. 1 Kraus, NE NE SE 20-14s-19w.

Huntington pool was opened in Graham County with Lansing production at Benson-Montin et al 1 Huntington, SE SE SW 7-7s-25w. Another new Graham County producing area in Southeast Law pool, opened at Heathman-Seeligson 1 Irwin, SW SW NE 12-10s-23w. This well is completing in the Penn conglomerate.

North Hearn pool was opened in Pawnee County on the southwest flank of the uplift at Loffland Bros. et al Grizzell, SW SW SE 23-23s-15w. The well was finaled for 1,634 M.c.f. of gas per day from the Simpson sand.

Southwest Hilgers pool opened at Fleming & Woodman et al 1 Geubelle, NW NW NW 29-26s-4w, Reno County, with production from the Viola lime.

Sheridan County Has Promising New Prospect

Sheridan County has a prospective Lansing discovery at Jones, Shelburne, and Farmer 1 Custer, NW NW SE 12-10s-26w.

A drill-stem test in the Lansing lime at 4,004-45 ft. got 420 ft. of oil-cut mud, 250 ft. muddy oil, and 900 ft. of oil. Operator has moved in cable tools. This wildcat is 7 miles southeast of George field.

OKLAHOMA

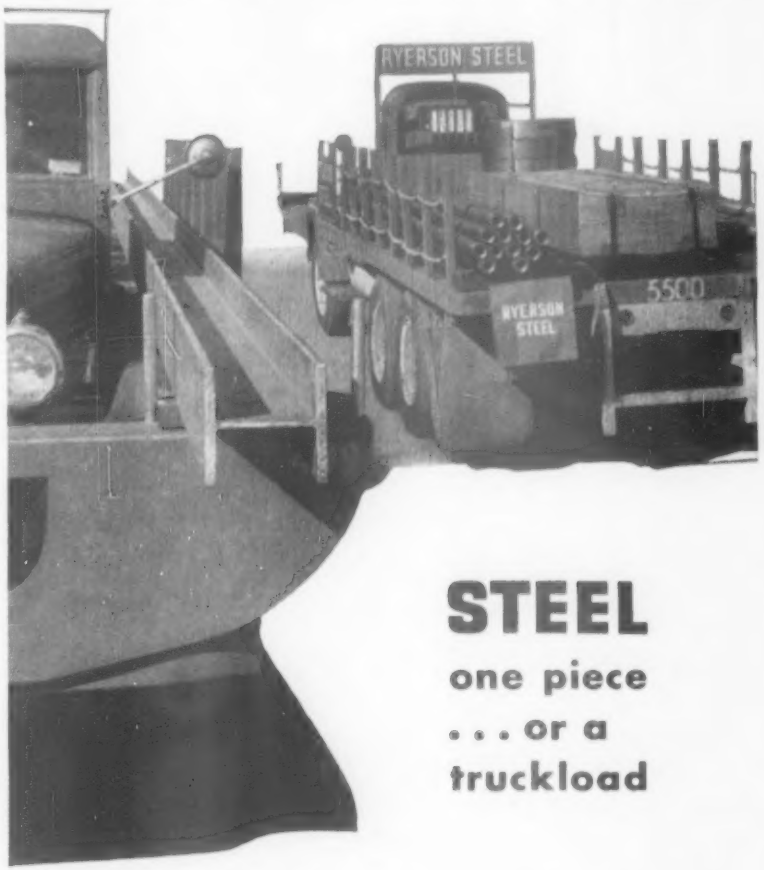
North Madill Field in Marshall County Develops

Marshall County's important North Madill field continues its expansion program. Sinclair Oil & Gas Co. 1 Nunley, SE NW NW 15-5s-5e, found the McLish sand at 6,732 ft. A drill-stem test at 6,724-54 ft. flowed an estimated 30 bbl. of oil hourly. The Bromide sands previously indicated distillate production.

Lone Grove Viola Area Being Extended by Frankfort

Frankfort Oil Co. is extending the new Viola sector near Lone Grove in Carter County at 1 Fowler, NW SE NW 17-5s-1w.

A core barrel at 5,175-94 ft. recovered 19 ft. of lime with porosity,



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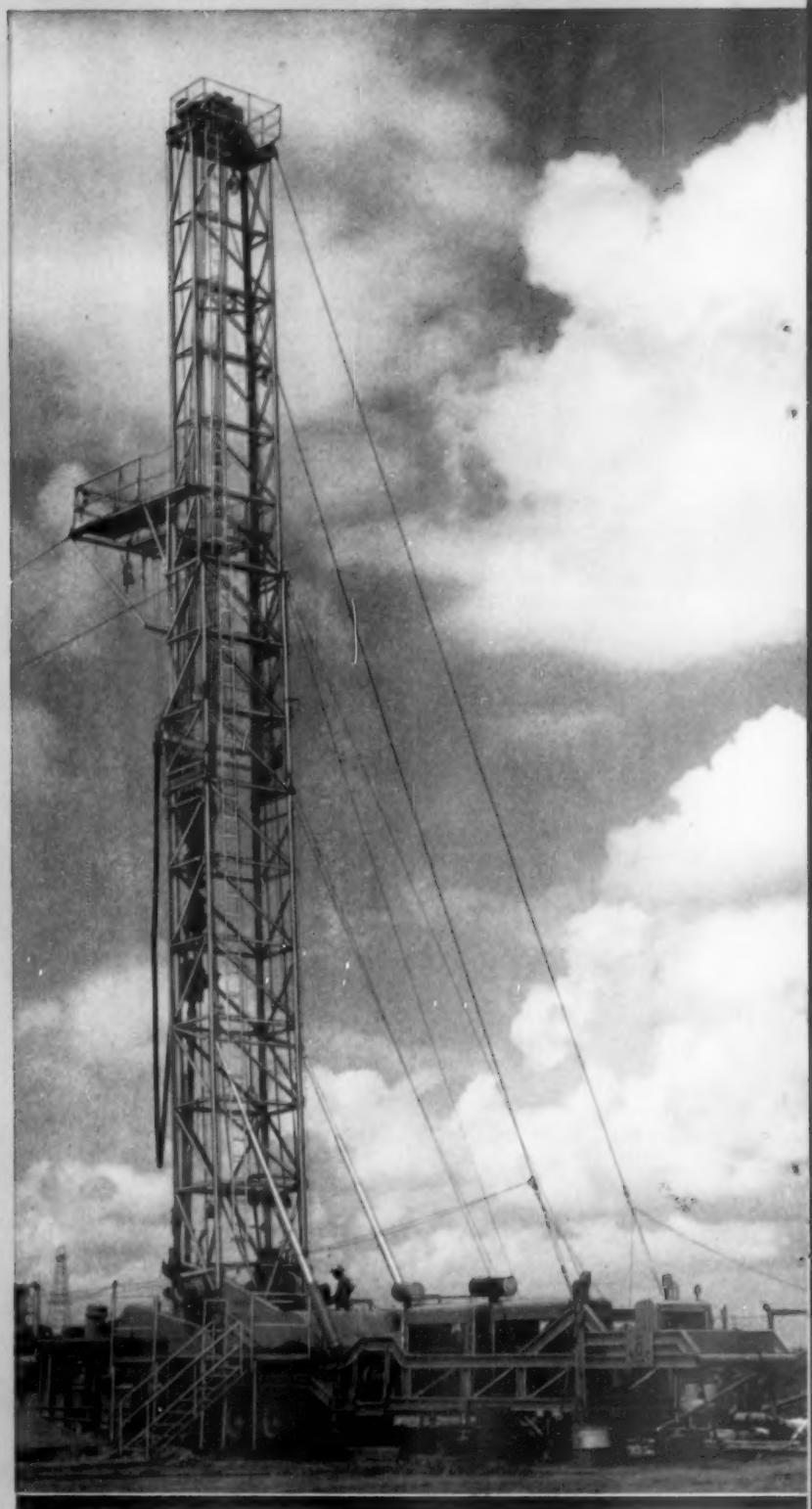

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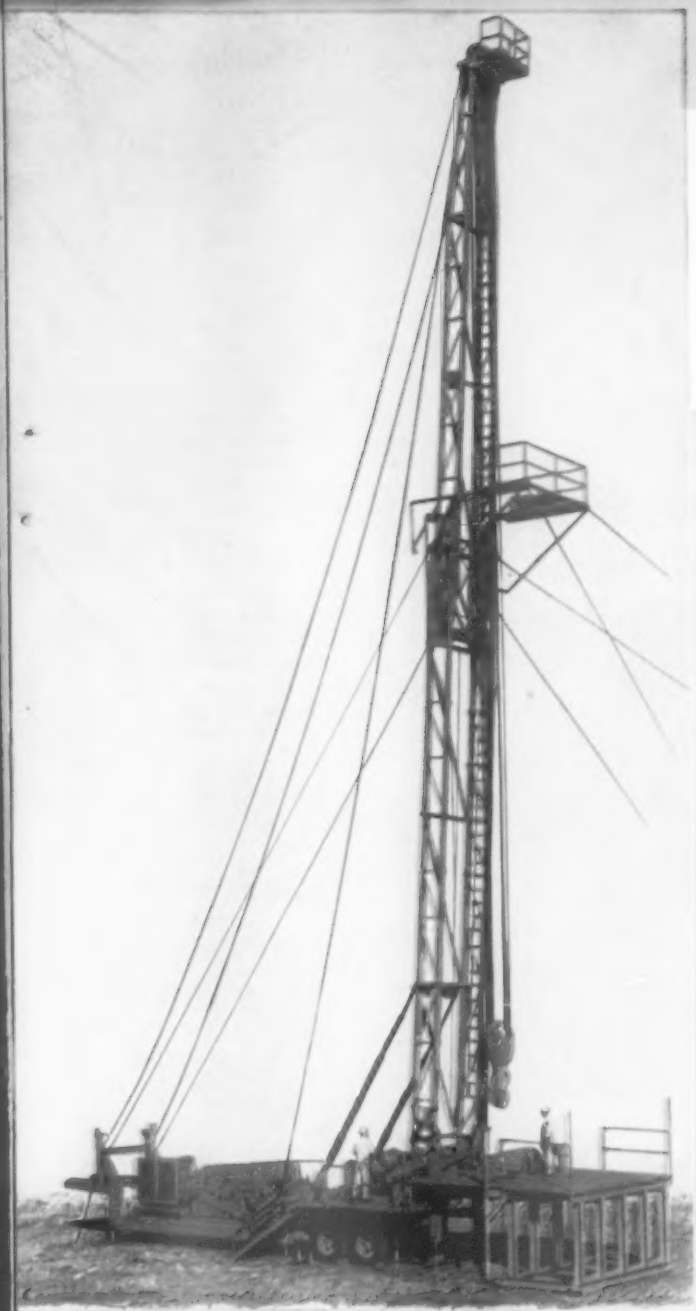

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stain, and odor. The core is similar to the one taken at the Viola discovery well in 12-5s-2w. The Viola is producing prolifically from about 5,100-6,000 ft. in this area. The current success, 1 Fowler, is 2 miles southeast of other Viola wells.

Samedan Oil Has Bromide Sand Show at North Madill

A second Bromide oil showing is to be evaluated at Samedan Oil Corp.'s 1 Bounds, NE SE NE 17-5s-5e, North Madill field well in Marshall County.

The showing was found at 5,860 ft. and the interval 5,865-5,921 ft. will be tested. Meanwhile, Buffalo Oil Co. 1 Olmstead, NE SW NE 16-5s-5e, flowed 144 bbl., 74 bbl., and 68 bbl. per day on declining flow tests from McLish sand at 6,012-44 ft. After fracturing the well flowed 116 bbl. in 4 hours and 120 bbl. in 2 hours for 38 bbl. of new oil.

A shallow Springer sand well recovered 125 ft. of oil and gas-cut mud on drill-stem test at 1,751-80 ft. in Madill field. It is Sinclair Oil & Gas Co.'s 1 Jacks, SE SW SE 9-5s-5e.

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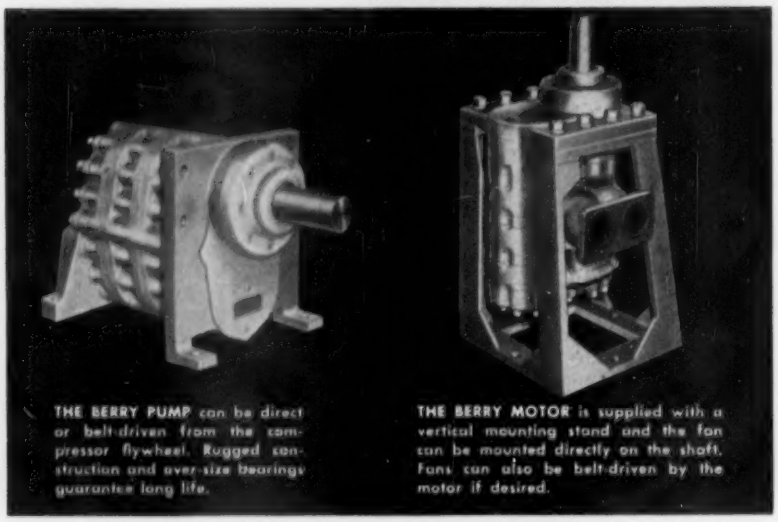

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HUGOTON EMBAYMENT

SOUTHWEST KANSAS

Testing Continues at Kiowa County Prospect

GMR Oil Co. 1 Piester, southeast of Pyle field in Kiowa County, continued to test in the Mississippian. The well swabbed 6 bbl. of oil and 1½ bbl. of water hourly after fracturing.

Later it swabbed 5 bbl. of oil hourly for 4 hours, 15 per cent water. The perforations are at 4,598-4,608 ft. This well is 2 miles southeast of Pyle field. It is in SW SW NW 24-29s-16w, 7½ miles south of Wellsford, Kans.

Pyle field . . . The northeast offset and confirmation well to Pyle field is rigging up cable tools.

Gulf Oil Corp.-Falcon-Seaboard 1 Zora, SW SW SW 10-29s-16w, 6 miles southeast of Haviland, tested in the Mississippian at 4,639-48 ft. Aurora Gasoline Co. abandoned the 1 Thompson in SW SW NW 4-28s-17w, 4 miles north of Brenham field in Kiowa County.

OKLAHOMA PANHANDLE

Third Pay Tested at Beaver County Discovery

Cities Service Oil Co. tested a third pay zone at its 1 Miles "B," SE SE NW 12-4n-24eCM, 5 miles northeast of Beaver City and 3 miles south of Southwest Mocane field.

The well flowed 150 M.c.f. of gas per day on test of upper Morrow sand through perforations at 6,496-6,510 ft. It flowed 4,500 M.c.f. per day from lower Morrow perforations at 6,618-98 ft. and 2,760 M.c.f. of gas from the Mississippian-Chester through perforations at 6,736-50 ft.

Lion Oil Co. 1 Hodges, SW NE 21-6n-24eCM, is still testing in the Council Grove of Permian Wolfcamp age. The well flowed 3,000 M.c.f. of gas from the Permian pay zone at 3,262-3,315 ft. This well is 4 miles northwest of Northwest Mocane field. It establishes the first "outside Hugoton field" Permian production for the region, more than 30 miles east of the big Hugoton gas field.

TEXAS PANHANDLE

Testing in Cherokee Continues at the 1 Nix

Testing continues at Sun Oil Co.'s 1 Nix, northwestern Hemphill County discovery 23 miles southeast of Lips Ranch field.

The Cherokee prospect, 2½ miles

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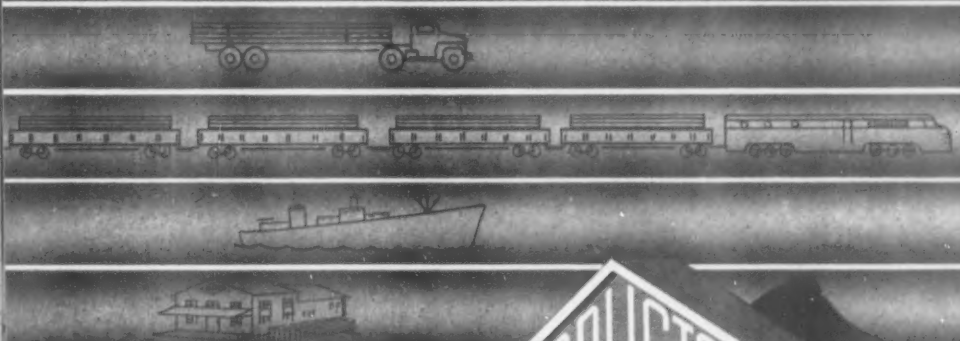

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northwest of the town of Canadian, is swabbing and flowing oil load after fracture treatment. The well is producing through open hole.

WEST TEXAS-NEW MEXICO

WEST TEXAS

Devonian Well has Water In Ellenburger

Humble 1 Rosa Barnett, Devonian discovery northeast of McCamey, entered the Ellenburger by samples at 11,554 ft., minus 8,457 ft. Initial test at 11,553-78 ft., open 2 hours, recovered 15 ft. of free oil and 30 ft. of sulfur water. Flowing pressure was 780 psi.; shut-in pressure was 5,015 psi. Operators cored ahead following the test.

Strawn Exploration Is Queen Sand Discovery

A dry hole in the Pennsylvanian Strawn at East Means field, has been plugged back to make a good flowing discovery in the Queen sand.

Forest Oil Corp. and Montery Oil Co. 1 University "D," ½-mile west of the lone producer at East Means, was dry at 11,410 ft. total depth. Operators

then plugged back to test the Queen sand between perforations at 4,710-58 ft. An initial flow test gaged 131 bbl. of new oil in 12 hours through ⅜-in. choke, with flowing tubing pressure of 130 psi., gas-oil ratio of 432:1 and 34.4°. This flow was made following a 500-gal. mud-acid treatment, and a 5,000-gal. fracture treatment. Location is in 19-4-University Lands Survey, 6 miles northeast of Andrews.

The high productive possibilities of the Queen sand were recognized last year when Humble Oil & Refining Co. opened production from that horizon in Means field.

Ward County . . . Cities Service Oil Co. 1-B Brandenburg, exploratory test in the Payton-Devonian area, has been completed as a dual producer. Production was from the Devonian, and the Ellenburger; the lower zone being a new pay in the field.

Completion potential on open-hole in the Ellenburger, at 10,086-10,215 ft., was 62,000 M.c.f. of gas, plus 45.84 bbl. of distillate per 1,000 M.c.f. The initial was open flow. Gas-oil ratio was 21,812:1, gravity of distillate was 64°, and flowing tubing pressure ranged from 1,695 psi. on 26/64-in. choke, to 3,003 psi. on 16/64-in. choke.

Devonian potential from 6,825-70, and 6,744-94 ft. was a calculated open flow of 12,500 M.c.f. of gas, plus 59.38 bbl. of distillate per 1,000 M.c.f. On tests, flowing tubing pressure ranged from 1,608 psi. on 27/64-in. choke, to 1,695 psi. on 18/64-in. choke.

Location is in 4-32-H&TC Survey, 2 miles southwest of Grandfalls.

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SOUTHWEST TEXAS

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Jim Wells County, has been opened by Steinmetz, Baron & Smith. Discovery well, 2 Reynolds, is rated good for 10,300,000 cu. ft. per day from casing-perforated sand at 3,138-64 ft. Shut-in pressure is 1,350 psi. The operators' first test, a location northeast, was dry.

Deep Test Projected in Remote Val Verde Field

Humble Oil & Refining Co. has scheduled a 13,000-ft. exploratory test in the old Vinegarone gas area, northeaster Val Verde County, in the remote upland sector of Southwest Texas.

This is the first activity in the area since July 1952, at which time four gas wells had been completed with production from a 10,200-ft. sand, believed to be in the lower Mississippian.

The area, located 10 miles northeast of Juneau, was discovered by Western Natural Gas Co.

Humble's new operation, 1 Coe, is in Section 26, Block A, C&M RR Survey.

Austin Chalk Produces in Two Frio Discoveries

Austin chalk is proving productive in two additional areas of Frio County, one 3 miles southwest and the other 7 miles southeast of Pearsall.

Southwest of Pearsall, James L. Williams has put his 1 Beal, discovery well, on the pump making 362.75 bbl. of 31.8°-gravity oil daily by agitation. Production is with gas-oil ratio of 200 cu. ft. per barrel. Top of the chalk pay is 5,600 ft. with hole open from 5,600 to 5,875 ft.

Sutton Drilling Co.'s new discovery well, 1 Brazeale, southeast of Pearsall, is pumping at the rate of 189 bbl. of 33°-gravity oil per day with pay in open hole at 5,550-5,703 ft.

The latter is 2½ miles southeast of another Austin chalk discovery well, 1 Newsom, completed by the same company last November with an initial flow rated good for 648 bbl. of 36°-gravity oil per day with pay at 5,240-85 ft.

TEXAS GULF COAST

Houston County Wildcat Flows Oil While Testing

Skelly Oil Co. has a new oil-discovery well in southern Houston County, where its 1 Martin, in the Samuel Haddox Survey, flowed clean oil when starting production tests. The well was shut-in without gaging until tankage can be provided.

Pay zone, possibly in the Buda or Georgetown, is perforated at 9,970-92 ft. Bottom of the hole is 10,007 ft.

Location, southwest of Lovelady, is 14 miles south of Crockett. It is 10 miles northeast of Fort Trinidad field, on the Houston County line, where production is from the Buda and Georgetown formation, in addition to the Woodbine-Dexter section.

Sinton Wildcat Produces

Chicago Corp.'s newly completed discovery well, 1-B Odem, east of Sinton, in San Patricio County, produced at the rate of 189 bbl. of 39°-gravity oil per day on potential gage through ¼-in. choke. It had flowing pressure of 1,590 psi. with gas-oil ratio of 4,856 cu. ft. per barrel. Pay is perforated at 7,323-32 ft.

SOUTH LOUISIANA

Two Gas Pools Opened In Gulf of Mexico

A new gas-distillate field has been opened off Cameron Parish and another in the Eugene Island Block 47 area of Iberia Parish.

Shell Oil Co. has established gas-distillate production at a wildcat in the East Cameron Block 17 area, about 12

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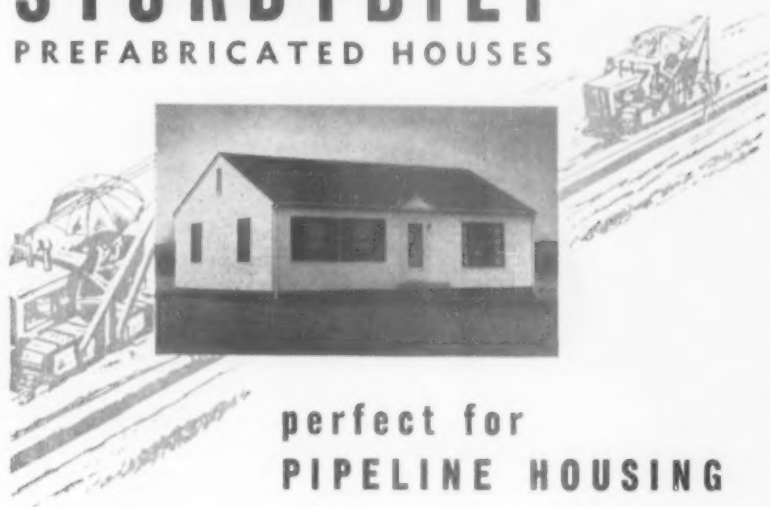

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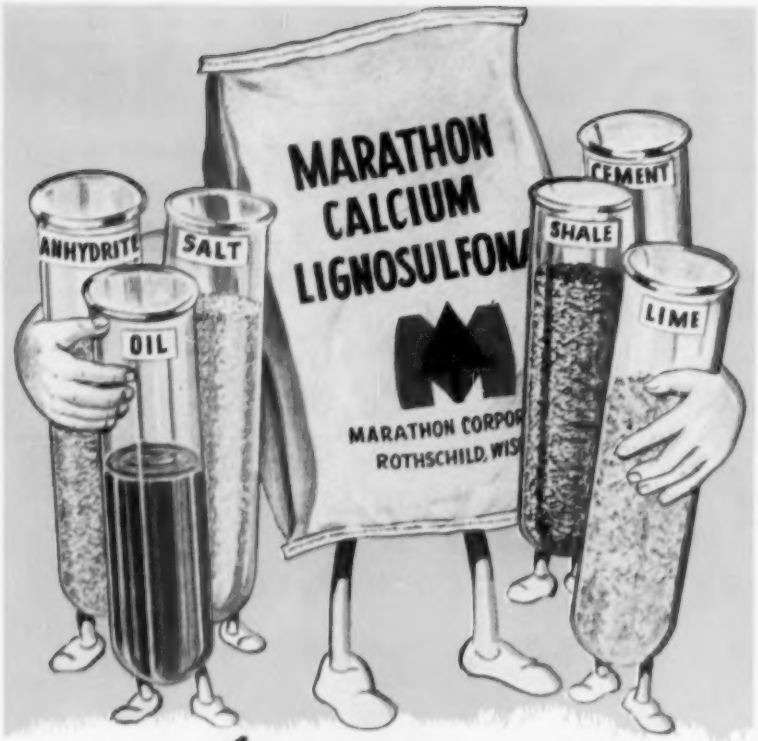

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miles south of Deep Lake field. The 1-A State Lease 2546 went to 13,719 ft. and plugged back to 11,900 ft. for tests. The well is shut in for potential after flowing an ungaged amount of gas-distillate from perforations in the 11,880-ft. sand on 13/64-in. choke. Pressure was 3,200 psi.

Pure Oil Co. opened gas-distillate production in Eugene Island Block 47, Iberia Parish, at 1-A State Lease 1079. The well tested gas and sprayed distillate from perforations at 8,480-94 ft. Gas-distillate ratio was 72,800:1.

Deepest Current Producer Established at Weeks Island

South Louisiana has the deepest producing well in the world at Humble Oil & Refining Co. 1 Juliet Hill Provost, on the northeast flank of Weeks Island dome, Iberia Parish.

Total depth of the well is 17,780 ft. It perforated at 17,440-45 ft., producing 81 bbl. of 44°-gravity distillate and 2,467 M.c.f. of gas per day on ⅛-in. choke. Gas-distillate ratio was 30,450:1.

The previous record was 2 Gonsoulin Minvielle State-Unit, a Shell Oil well on the north flank of Weeks Island dome. This well flowed gas-distillate from 17,260-306 ft. Two other wells in the field produce from below 17,000-ft. sands in the field. Another Shell well is scheduled for 18,350 ft., ½ mile north of the dome. This well might make a new record for the state and the world. California has the deepest production in the world, but the well out there is not producing.

GREAT LAKES

MICHIGAN

Location Cleared for Gilmore Township Offset

Location was being cleared for the diagonal southeast 40-acre offset to the new Gilmore Township, Isabella County, Dundee oil discovery. Drilling is due for an early start as the discovery well, John Neyer et al 3 Powell, SE SE NE 30-16n-5w, was being pumped natural for an average 15 bbl. per day. The well is being produced from the Dundee at 3,806 ft., total depth. The next start, one of three offsets staked, will be in the SE NW SW 29-16n-5w at the 4 Powell.

Ravenna field . . . Another Traverse oil well was completed in the east extension area of this field in Muskegon County at R. G. Smith 1 Sklepinski, NE NE NE 28-9n-14w. The well pumped an average of 60 bbl. of oil per day natural plus water from Trav-

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erse pay at 1,890 ft., total depth. This new producer, third to be completed in this extended portion of the field, is the diagonal northeast 20-acre offset to the extension producer which flowed at a restricted rate of 6 bbl. of oil per hour natural with no water showing.

Skeels field . . . The second good Dundee flowing oil well in the Franklin Township, Clare County division of this well was scheduled to be flowed at a restricted rate of 200 bbl. of oil per day.

This new well is the Don Rayburn 2 Roemelen et al, NE SE NE 25-20n-3w. Well is the north 10-acre offset to first Dundee well drilled on this same lease by Rayburn.

EASTERN INTERIOR

ILLINOIS

In Crawford County 7 miles south of Robinson in 6 and 7, 5n-12w, Frederking & Wagemann, Tide Water, and Wrather are in the midst of a rapid extension program with Benoist wells of good success as their reward.

This southeastern extension to Main Consolidated field has seven new wells producing, three completing, five under way, and one location staked. The best well in the area so far is Tide Water 1 Kizzie Hudson, SE NE SW 6-5n-12w. It is flowing 394 bbl. of oil with no water from the Benoist sand at 1,361-74 ft. daily.

An active Benoist sand (Mississippian) play is picking up considerable steam in the southeast extension area of Main Consolidated field in Crawford County.

● In Wabash County Skiles Oil Co has the first Tar Springs well in the area 1 mile west of Mount Carmel, NWc 19-1s-12w. It is the 2 Charles Steckler. It swabbed 5 bbl. of oil per hour from perforations at 1,735-40 ft. after shot.

In Effingham County, Ben Reiss and Dave Coslet 1 Nora Gaddey, SW SW SE 1-6n-6e, 2 miles south of Watson, swabbed at the rate of 336 bbl. of oil per day after shot in the Cypress sand (Mississippian) at 2,459-68 ft. This new well is 1½ miles northeast of East Hill pool. The well should open a new play in the area.

● In Jasper County, 6 miles southeast of Newton, Pure Oil Co. extended Salem pay in Clay City Consolidated pool ½ mile at the 4 Mike Bolander "A," NW SW NE 4-5n-10e. The well is pumping at the rate of 36 bbl. of oil per day from the Salem lime (Mississippian) at 3,286-3,304 ft.

WESTERN KENTUCKY

The most active area in Western Kentucky is at the Christian-Muhlenberg-Todd County intersection. There are 27 opeartions active at the moment. In Christian County, 2 miles south of Apex, 2-G-26, Sargent and Vogler 7 Littlepage Minerals flowed oil from the Jackson sand at 473-98 ft.

In Muhlenberg County, W. E. Williams Drilling Co. 1 Bobby Combs, 12-H-27, 5 miles south of Greenville, is a new wildcat under way, 3 miles from production. In Todd County, Central Drilling Co. 1 Earl Walker, 10-G-27, 7 miles southwest of Greenville, swabbed and flowed 110 bbl. of oil daily from the McClosky lime (Mississippian) at 934-40 ft.

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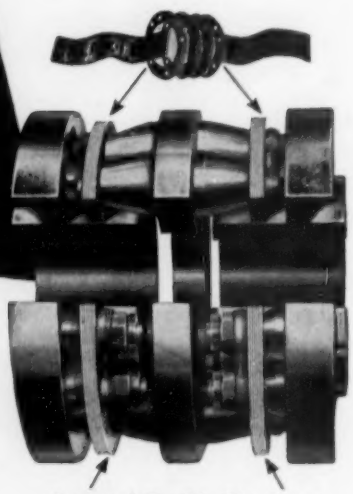

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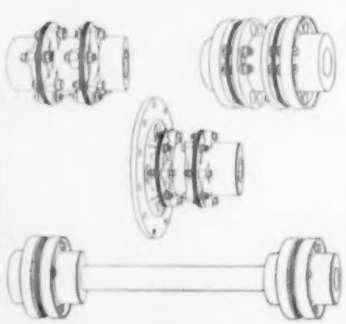

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PACIFIC COAST

CALIFORNIA

New Deep Test for Sacramento Valley

General Petroleum Corp. was preparing to spud a new deep test in the Saxon area of Yolo County, 10 miles

General Petroleum Corp. will drill the deepest test yet for the Sacramento Valley, 10 miles south of California's capital city. The well will go to about 15,000 ft.

south of Sacramento. The wildcat 65-10 Glide-Court is scheduled to drill to about 15,000 ft., making it the deepest test ever planned for Sacramento Valley.

Location of the well is in 10-7n-3e. It will be less than a mile from a 13,321-ft. dry hole the company drilled last year. About 3 miles west of the new test, Humble Oil & Refining Co. abandoned a 13-060-ft. test in 1953.

APPALACHIAN

WEST VIRGINIA

In Washington district, Upshur County, West Virginia, George I. Tennant has located 1 Catherine Rohrbough, wildcat, elevation 1,920 ft., Sago Quadrangle, 4.02 miles south of latitude 38 degrees 55 minutes and 2.80 miles west of longitude 80 degrees 50 minutes.

- Gore district, Hempshire County, M. E. Anderson 1 J. E. & B. Ornuff is drilling at 1,134 ft.
- Licking district, Tucker County, Hope Natural Gas Co. 9924 Alex Nestor Hrs. is at 4,260 ft.
- Beaver district, Nicholas County, Nelson W. Taylor, Agt., 1 John Mearns is drilling at 800 ft.

OHIO

Joe Swingle et al 1 E. W. Montgomery, Lot 15, Madison Township, Licking County, extends the Marne

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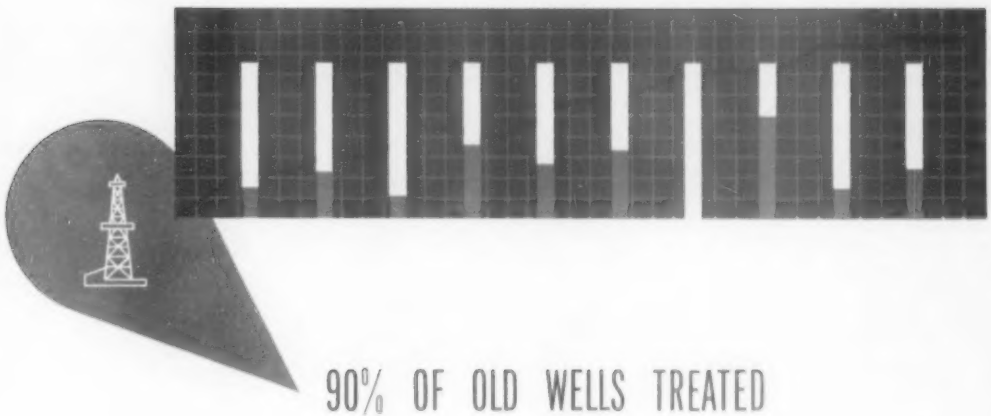

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pool ½ mile to the north. Clinton sand at 2,700-47 ft. was fractured and made 50 bbl. and 160,000 cu. ft. gas in the first 24-hour test.

● An outside location to Flint Ridge pool in Hopewell Township, Licking County, proved to be an 83-bbl. well with 1,800,000 cu. ft. gas after treatment. National Gas 3 Caughenbaugh, Lot 10, reported 10 bbl. natural in Clinton at 3,141-90 ft.

● In New Castle pool, Pure Oil 2 Levi Beale, Section 13, New Castle Township, Coshocton County, an outside location, made 90 bbl. after fracturing Clinton at 3,308-51 ft.

EASTERN KENTUCKY

United Fuel Gas Co. has completed their 12 Fordson Coal Co. wildcat test as a dry hole. Test was located on Woodson Fork of Bowens Creek and was drilled to a total depth of 3,124 ft. Corniferous lime topped at 3,033 ft. carried a 2 bbl. per day natural showing of oil from 3,069-71 ft. A show of gas was had at 3,036 ft. At total depth well was in Clinton shale.

ROCKY MOUNTAIN

MONTANA

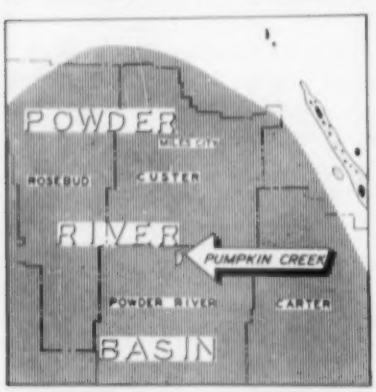
Exploration Scheduled for Powder River Basin Area

Agreements providing for drilling of 20 to 25 exploratory wells in Custer, Rosebud and Powder River counties have been concluded between George J. Greer, Trustee, and El Paso Natural Gas Co. Greer holds extensive leases in the three counties.

During 1954 Greer completed gas discovery in Eagle sandstone in the Pumpkin Creek district of Powder River County. Three additional gas wells and four dry holes have been completed in the area. The agreement with El Paso will bring that firm into the area as an operator for the first time. El Paso will participate in exploration of blocks of leases held by Greer. Terms of the agreement, except that it proposes completion of 20 to 25 wells before the end of the year, have not been announced. A majority of the expected drilling is to be slim-hole.

A part of the acreage adjoins the producing Pumpkin Creek area, with other blocks scattered through the surrounding portion of the Powder River basin. A considerable amount of Northern Pacific Railroad acreage is reported under lease to Greer, and included in the agreement.

There has been a relatively small amount of exploration in the Montana portion of the Powder River basin, with no success in the eastern basin area in the state prior to the Greer gas discovery.



Agreements providing for drilling of about 25 wildcat wells in Custer, Rosebud, and Powder River counties, Montana, have been completed between Greer, Trustee, and El Paso Natural Gas Co.

Shell Oil Co. has recovered 1,400 ft. of gassy oil on a drill-stem test of its Gas City wildcat in Dawson County on the Cedar Creek anticline, 2 miles southeast of Yellowstone field (Ordovician). The pay zone is Mission Canyon (Mississippian).

New Pay Tested in Northwest Sumatra Field

McAlester Fuel Corp. has recovered oil from an apparent fourth pay zone in Northwest Sumatra field of Rosebud County. The well, 4 NP, C NE SE 7-11n-32e, topped the "A" zone of Heath at 4,319 ft. and recovered 46 ft. of saturated sand in cores. The operator tested a portion of this sand from 4,319-28 ft. with recovery of 900 ft. of clean oil in 30 minutes under flowing pressures of 45-295 psi. Total depth of the well was last reported as 4,544 ft. with the operator coring after already recovering 22 ft. of saturated sand from the "B" zone.

The field has produced from "B" and "C" zones of Heath and from Amsden dolomite. The current test in "A" zone marks the first oil recovery from the formation at Northwest Sumatra. The field has been one of the most active of Montana areas during the past 2 years. As a result of success in lenticular sands at Northwest Sumatra the search for similar producing areas through central Montana has increased in interest.

Red River Yields Water at Dawson County Wildcat

Gulf Oil Corp. recovered gas-cut salt water on test of Red River at 1 Schwarz, C SE NE 3-17n-52e, Dawson County. The operator tested the interval 10,384-10,477 ft. Top of Red River was called at 10,295 ft. Two earlier tests recovered a small amount of oil with oil-cut mud, and gas-cut mud. Gulf is coring below 10,750 ft. The wildcat is to test to Ordovician.

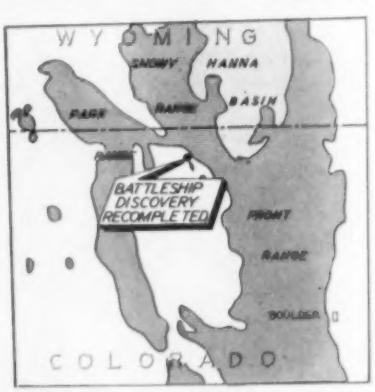
COLORADO

Morgan County Wildcat Flows Gas

Humphries and Siler recovered 3,000 M.c.f. of gas per day on test of 1 Muir, C NE SW 9-3n-57w, Morgan County. The well tested D sand at 5,408-32 ft. Location is 2½ miles northeast of Fort Morgan.

Jackson County Discovery Completed in New Horizon

Lion Oil Co. has recompleted its 1954 discovery in the Battleship area of Jackson County. The well, 1 Dwinell, C NE SW 23-10n-79w, was originally completed for a pump gage of 195 bbl. of oil per day from Dakota. Lakota was tested prior to this completion, but no attempt at a dual completion was made. The present completion is in Lakota. Lion reported pump recovery of 500 bbl. of oil per day



Lion Oil Co. has recompleted its 1954 discovery in the Battleship area of Jackson County in the North Park basin. The 1 Dwinell was formerly completed in the Dakota. The new completion is in the Lakota.

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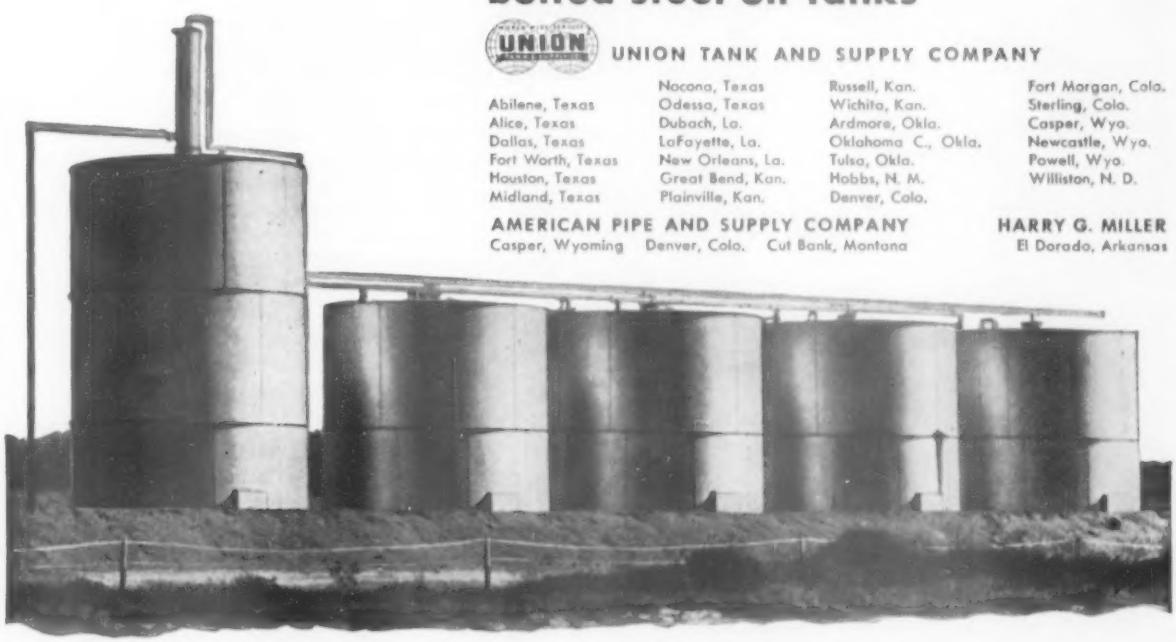

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from Lakota perforations at 4,654-64 ft. Decline in production from Dakota led to the workover. Lion is drilling below 4,700 ft. at a second well in this area, 2 Dwinell, C SE SW 23-10n-79w.

WYOMING

Pump Gage Reported at Washakie County Discovery

Superior Oil Co. reported pump recovery of 223 bbl. of oil per day on initial pump tests of 1 Government-Chittim, C SW SW 29-47n-90w, Washakie County. The wildcat found production Phosphoria at 8,800-32 ft. The well is 4 miles southeast of Phosphoria production in the Cottonwood Creek area of Washakie County. The new pool has been designated Meyer Gulch.

New Pay Tested At Circle Ridge

Continental Oil Co. has reported recovery of oil on test of Amsden at 45 Shoshone-66, SE NW SW 6-6n-2w, in Circle Ridge field, Fremont County. The operator swabbed 52 bbl. of 23.9°-gravity oil in 5 hours at 881-938 ft. A second test at 940-1,000 ft. recovered 5½ bbl. of oil in 4 hours of swabbing. There has been no previous production from this formation in the field. Production is from Phosphoria and Tensleep. Continental will drill ahead to test Madison in the current well.

NORTH DAKOTA

Two Bottineau County Wildcats Active

Calvert Drilling Co. is drilling below 3,071 ft. at 1 Sirecks, SE NE 14-162n-79w, Bottineau County. The wildcat was reported in Spearfish at this depth. It is to be a test of Lodgepole. It is one of two wildcats in Bottineau County by this operator. The other, 1 Nelson, SE SE 19-163n-78w, has not been spudded.

WESTERN CANADA

ALBERTA

Pembina Well Completed By Canadian Bishop Oil Co.

Canadian Bishop Oil, Ltd., announced that it has completed its 2-4 Pembina well on a 320-acre lease in Alberta Province, Canada.

The well was brought in flowing at the rate of 243 bbl. in 24 hours through a small choke. Casing pressure is 850

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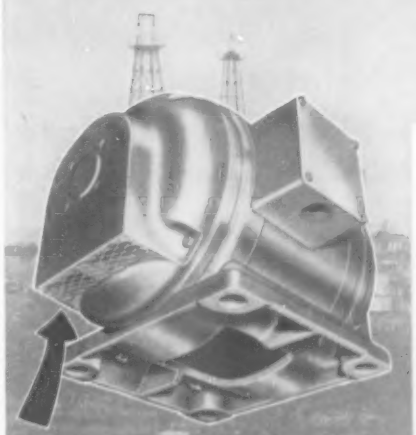

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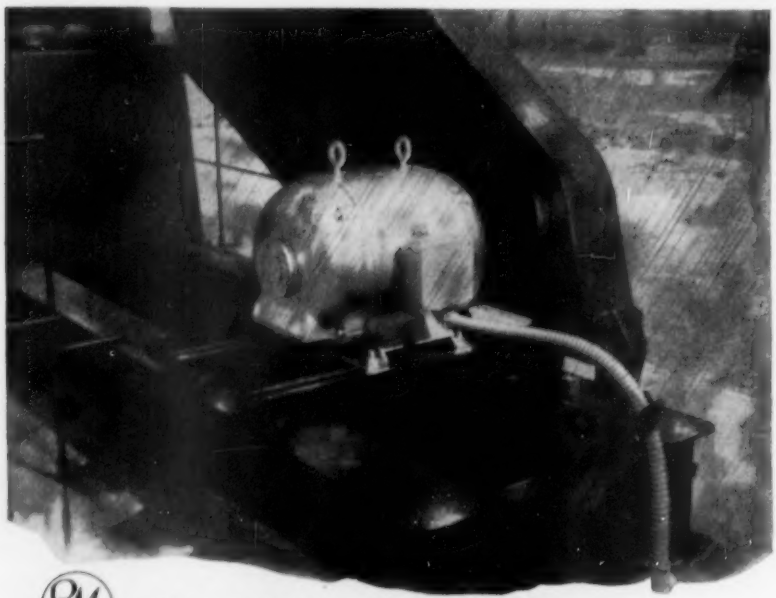
The company announced that its 4-4 Pembina on the same lease is drilling ahead at 3,780 ft. The 2-4 Pembina is the company's third well on the property, and 4-4 the fourth. Oil is 37° gravity, which sells at $2.48 per barrel. The current field allowable is 105 bbl. per well per day. There is a pipeline connection to the property.

South Joffre Area Test Gets Light Gravity Oil

Seaboard Oil Co. and its associates, Honolulu Oil Corp., Merrill Petroleums, Ltd., and Cancoll Oil & Gas, Ltd., obtained an encouraging rise of light-gravity crude oil at their wildcat in the South Joffre area of central Alberta. The well lies on a Canadian Superior of California, Ltd., farmout, about 10 miles east of Red Deer.

This oil discovery, 7-7 South Joffre, LSD 7, 7-38-25w4, ran a series of three tests in the Viking sand. Initial test gave up mud recovery, while the second test at 4,910-35 ft. flowed gas at the rate too small to measure. Recovery consisted of 550 ft. of oil and 25 ft. of mud. The third test got only mud. The crew is drilling toward the Devonian objective.



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BRITISH COLUMBIA

Triassic Gas Found at Nig Creek Area Wildcat

The Northern Foothills Agreement Group, shared equally by Texaco, Socony, Shell, and Canadian Gulf, has discovered gas in the Triassic zone at their current wildcat test in the Nig Creek area.

This well, 6 Nig Creek, located 57° 5', 39", North Latitude and 121°, 38', 42" West Longitude, is located about 4 miles northeast of the 1 Nig Creek gas strike. On second test at 4,223-59 ft. the wildcat flowed gas in 3 minutes at the rate of 2,487 M.c.f. per day. The crew is drilling below 4,312 ft.

Successful Wildcats

MICHIGAN

Clare County: Don Rayburn 2 Meyer, NE NE SE 25-20n-3w. IPP 16 BOD, Traverse 3,103 ft., pay 3,103-08 ft., TD 3,998 ft. (dry in Dundee) PBTD 3,298 ft. (New, shallower pay in Skeels pool.)

SOUTHWEST TEXAS

District 4

Brooks County: Bridwell Oil Co. 1 Jack Casey, Jas. T. Mauphin Sur. 631, 14 miles southwest of Falfurrias. IPF 123 BOPD, 5,667-75 ft., top pay 5,667 ft., ¼-in. choke, GOR 160:1, 40.5°. TD 6,215 ft. (Oil discovery.)

Jim Hogg County: Paul J. Moore 1 T. G. de Gutierrez, Sur. 164, 12 miles southwest of Hebbronville, IPF 65 BOPD, 12/64-in., 33°, Loma Novia 3,207 ft., perfs. 3,207½-16½ ft. TD 3,225 ft. (Oil well.)

Willacy County: Roy H. Bettis and G. F. Sheperd 1 A. C. de Olivares, San Juan de Carricitos Grant, IPP 31.8 BOPD, top pay 2,985 ft., perfs. 7,988-8,042 ft., 30.7°. TD 8,093 ft. (Extends West Willamar field.)

TEXAS GULF COAST

District 3

Colorado County: Sinclair Oil & Gas Co. 1 LeRoy J. Burt, Jr., D. Gilliland A-26. IP 2,550 M.c.f. of gas per day, open flow, 52°, Top of Wilcox pay 10,363 ft., perfs. 10,363-73 ft., 10,410-15, 10,421-26, and 10,443-51. GLR 22,000:1. TD 10,495 ft. (Gas-distillate discovery well.)

Galveston County: Superior Oil Co. 1 Cooper "A" Unit, I&GN 13 A-601. IP 44,000 M.c.f. of gas per day, open flow, 52.6°, top of 32 sand pay 9,390 ft., perfs. 9,390-9,408 ft. GLR 44,740:1. TD 12,415 ft. (dual gas-oil well.)

Jefferson County: Cyprus Oil Co. et al 1 George R. Bauer, G. J. Peterson, T&NO 66, A-598. IP 39,000 M.c.f. of gas per day, open flow, top Nodosaria pay 9,440 ft., 55.5°, GLR 36,200:1, perfs. 9,440-74 ft. TD 9,646 ft. (Gas-distillate discovery well.)

Hardin County: American Republics Corp. and Houston Oil Co. 3 H&TC, Sec. 185, A-298. IP 42.84 BOPD, 8/64-in. choke, top 4-B Yegua pay 6,801 ft., perfs. 6,801-06 ft. 40.3°, GOR 1,411:1. TD 7,650 ft. (New pay oil discovery in Karl Gore field.)

EAST TEXAS

Cass County: F. R. Jackson 1 Baldwin, James

Taylor Sur., A-1029, 4 miles E Kildare, 1½ miles NE Haynes field. IP 176 BOPD, 10/64-in., 40°, CP 750 psi., GOR 700, perforated Hill zone of Rodessa 5,846-58 ft., IP 187 BOPD, 10/64-in., 40°, TP 650 psi., GOR 500, Gloyd zone 5,968-74 ft. TD 6,713 ft. Dual completion.

Limestone County: Lawton Oil Corp. 1-A Tucker, Mariano Riva Palacios Grant, A-21, 4½ miles SE Fallon. IP 1,000 M.c.f., plus 20 bbl. distillate per day, ¼-in. choke, TP 600 psi., Travis peak 7,638-46, 7,651-57, 7,660-74 ft. TD 1,953 ft.

TEXAS PANHANDLE

Gray County: Phillips Petroleum Co. 1-A Troy, SE NW 82-M2-H&GN. IP 299 BOPD, 42.2°, Ellenburger 11,220-90 ft. TD 11,370 ft. First Ellenburger completion, and new producing depth record in the Panhandle.

Robert County: Cree Drilling Co. 1 Shell-Flowers, Blk. C-75, G&M Sur. IP 11,213 M.c.f., pay 3,760-88 ft. TD 3,860 ft.

WEST CENTRAL TEXAS

Fisher County: Sid Katz et al 2 Nina Wheeler, T. Crosby Sur. 220, 9 miles N Trent, twin well to 1 Wheeler, Strawn discovery. IPP 20 BOPD, 40°, GOR zero, pay 2,649-56 ft. TD 2,711 ft.

Jones County: J. C. Hunter, Jr. 2-C Minter, Robert Smith Sur. 192, 2 miles E Hawley. IPP 71 BOPD, 37°, GOR 40, Flippen lime 1,981-85 ft. TD 5,447 ft.

Stonewall County: J. C. Hunter 1 Poore, 176-D-H&TC, 9 miles N Aspermont. IPP 23.66 BOPD, 38°, GOR 100, Tannehill sand 3,182 ft. TD 6,370 ft.

NORTH TEXAS

Archer County: Perry & Moody 1 White, T. Freeman Sur., A-134, 2 miles S Holliday. IPP 12 BOPD, 35°, GOR zero, Cisco 617 ft. TD 620 ft.

Cooke County: Ralph J. Abbey 1 Dozier, J. W. Hamilton Sur., Blk. 3, 10½ miles NE Gainesville. IPP 177 BOPD, 40°, GOR 200, Oil Creek sand 6,351-55 ft. TD 6,574 ft.

Grayson County: Lone Star Producing Co. 1 Mayhew, Geo. B. Pilant Sur., A-963, 2 miles SE Sherman. IP 262.7 BOPD ¼-in., 40.8°, TP 595 psi., GOR 1860, top pay 10,885 ft. TD 10,990 ft.

Wise County: Christie, Mitchell & Mitchell 1 Bilberry Unit, D. Moses Sur., A-543, 4½ miles N Boonesville. IP 160.7 BOPD, ¼-in., TP 275 psi., 40°, pay 4,600 ft. TD 5,900 ft.

SOUTHEAST NEW MEXICO

Lion Oil Co. 2 Federal-Erwin, 4-15s-31e. IP 420 BOPD, open tubing, 38°, TP 45 psi., GOR not reported. Queen sand 3,116 ft., pay 3,119 ft. TD 3,187 ft.

WEST TEXAS

Pecos County: Zapata Drilling Co. 1 Atlantic State, 106-OW-GC&SF. IPP 85.8 BOPD, 36°, GOR zero, top pay 3,158 ft. TD 3,232 ft.

INDIANA

DuBois County: R. Dyer 1 Roesner, NE SE NE 35-3s-6w. IPP 35 BOPD Aux Vases sand 1,116-21 ft. TD 1,151 ft. (Oil discovery of Holland field.)

SOUTH LOUISIANA

Acadia Parish: The California Co. 1 Theoza Martin, 9-9s-3e. IPF 270 BOPD, and 2,060 M.c.f. of gas per day, 11/64-in. choke, GOR 8370:1, 47°, perfs. 13,244-253½ ft. TD 14,337 ft. (Gas-distillate discovery.)

Iberville Parish: Temple Hargrove et al 3-A E. B. Schwing, 29-8s-11e. IPF 190 BOPD, 9/64-in. choke, 50°, perfs. 9,071-90 ft., GOR 8000:1. Top Marginulina pay 9,071 ft. TD 9,650 ft. (New oil sand in Bayou Choctaw field.)

Lafourche Parish: Humble Oil & Refining Co. 1 W. Alton Jones, 30-17s-23e. IPF 194 BOPD, 429 M.c.f. of gas per day, ⅛-in., 35.2°, perfs. 10,669-79 ft. TD 12,090 ft. (Oil discovery at Little Temple.)

Plaquemines Parish: Shell Oil Co. 2 State Lease 2590, offshore. IPF 167 BOPD, 2,660 M.c.f. of gas per day, 14/64-in., 42°, perfs. 8,336-40 ft. GOR 15,907:1. TD 8,701 ft. (Confirmation and new gas-distillate pay for South Pass Block 6 field.)

St. Landry Parish: Fidelity Oil & Royalty Co. 1 Guillory, 48-6s-2e. IPF 99 BDPD, 2,268 M.c.f. of gas per day, 11/64-in., 59°, perfs. 8,793-8,801 ft., GOR 22,684:1. TD 9,520 ft. (New gas-distillate pay at Savoy.)

Vermilion Parish: Houston Oil Co. of Texas 1 Pierce, 87-14s-3e. IPF 163 BOPD, ¼-in. 34.6°, perfs. 12,360-66 ft., GOR 878:1, ¾ mile southwest nearest production. TD 13,130 ft. (Southwest Extension to Live Oak field.)

NORTH LOUISIANA

Bossier Parish: Carter Oil Co. 1 Edith Hardcastle Smith, ½ mile south of Arkana, 2-23n-13w. IPF at rate of 216 bbl. oil daily on 13-hour test, 14/64-in., 51.8°, Smackover "A" 10,733-64 ft. TD 11,193 ft. (Discovery of Arkana field.)

Tensas Parish: Phillips Petroleum Co. 1 Plane-McDonald Unit, SW SW 46-11n-12e. IPF at rate of 292 BOPD, 10/64-in., 40.2°, Tuscaloosa 9,161-67 ft. TD 9,218 ft. (Extension to Locust Ridge field.)

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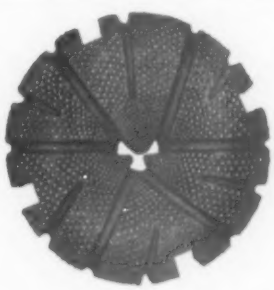

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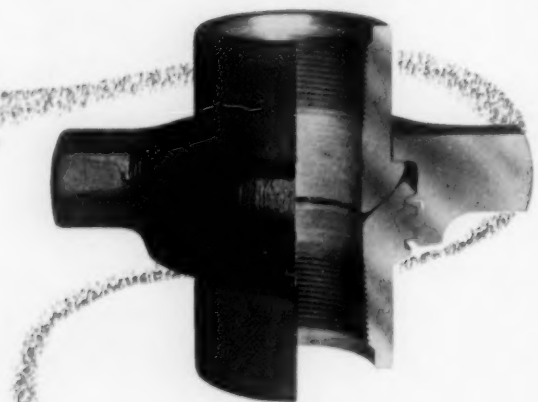

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ARKANSAS

Lafayette County: W. A. Sanders 1 M. W. Rowe, C SE SE NE 11-16s-23w, ⅝ mile northwest of Buckner, ⅞ mile northeast of East Stamps field. IPP 48 BOPD, 30 BWPD, Tokio 2-538-43 ft., 17.5°. TD 2,622 ft. (Extension to East Stamps field.)

OKLAHOMA

Beaver County: Pure Oil Co. 2 Dixon, C NE SW 29-5n-26eCM. IP 6,500 M.c.f. of gas per day, Upper Morrow sand 6,828-98 ft. TD 7,233 ft. (Gas discovery.)

Craig County: Frankfort 1 Van Ausdal, 1¼ miles south of gas production, SE NE NW 31-28n-20e. TD 2,014 ft. (Gas discovery.)

Hughes County: HBH Oil Co. 1 Buchner, 2½ miles southeast of Horntown, SW NE NW 13-7n-10e. IP 9,580 M.c.f. of gas per day, Buchner 2,497-2,505 ft., open tubing. TD 2,717 ft. (Gas discovery.)

Logan County: Powel Briscoe 1 Poteet, 1½ miles east of East Guthrie Lake field, SW NE NE 11-15n-2w. IPF 5 BDPD, 2,000 M.c.f. of gas per day, Layton 4,586-96 ft., ½-in. 67°. TD 6,235 ft. (Gas-distillate discovery.)

KANSAS

Reno County: Fleming & Woodman-Oyster 1 Geubelle, NW NW NW 29-26s-4w. IPP 232 BOPD, Viola lime 4,012-16 ft. TD 4,033 ft. (Opens Southwest Hilger field.)

CALIFORNIA

Kings County: G & H Oil Co. 46-20 Reserve-Martin, NE SW 20-24s-18e, IPF 200 BOPD, 14/64-in. choke, 38° gravity, perfs. 3,650-82 ft., TD 4,983 ft. (New pool discovery in Pyramid Hills area.)

Los Angeles County: Oceanic Oil Co. 1 Brown-Updike, 28-4s-12w, IPF 880 M.c.f. gas, 10/64-in. choke, perfs. 5,345-95 ft. in Brown zone, TD 9,973 (New pool discovery on east flank of Long Beach field.)

Orange County: Signal Oil & Gas Co. 161-A Signal-Bolsa, SE NW 29-5s-11w, IPP 75 BOPD, 33.5° gravity, 30 per cent cut, perfs. at 10 intervals between 7,546-7,932 ft., TD 8,000 ft. (Extenson of deeper pool on north edge of Huntington Beach field.)

WYOMING

Albany County, Seven Mile: The California Co. 3 Unit, SE SW 9-17n-77w. IPP 122 BOPD, Lakota discovery, new pay. TD 8,284 ft. Lakota.

COLORADO

Morgan County: Petroleum, Inc. 1 Peterson, NW NW NE 20-2n-56w. IPF 6 BOPH, "D" sand discovery, new field. TD 5,323 ft. "J" sand.

Weld County, Riverside: Great Basins and Sorrelle & Sorrelle 1 McPherson, C NE SE 19-5n-61w. IP 15,000 M.c.f. of gas per day, "J" sand discovery, new field. TD 6,840 ft. Skull Creek.

SASKATCHEWAN

Imperial 8-34 Antler River, LSD 8, 34-3-33w1. Indicated Mission Canyon oil well. TD 4,445 ft.

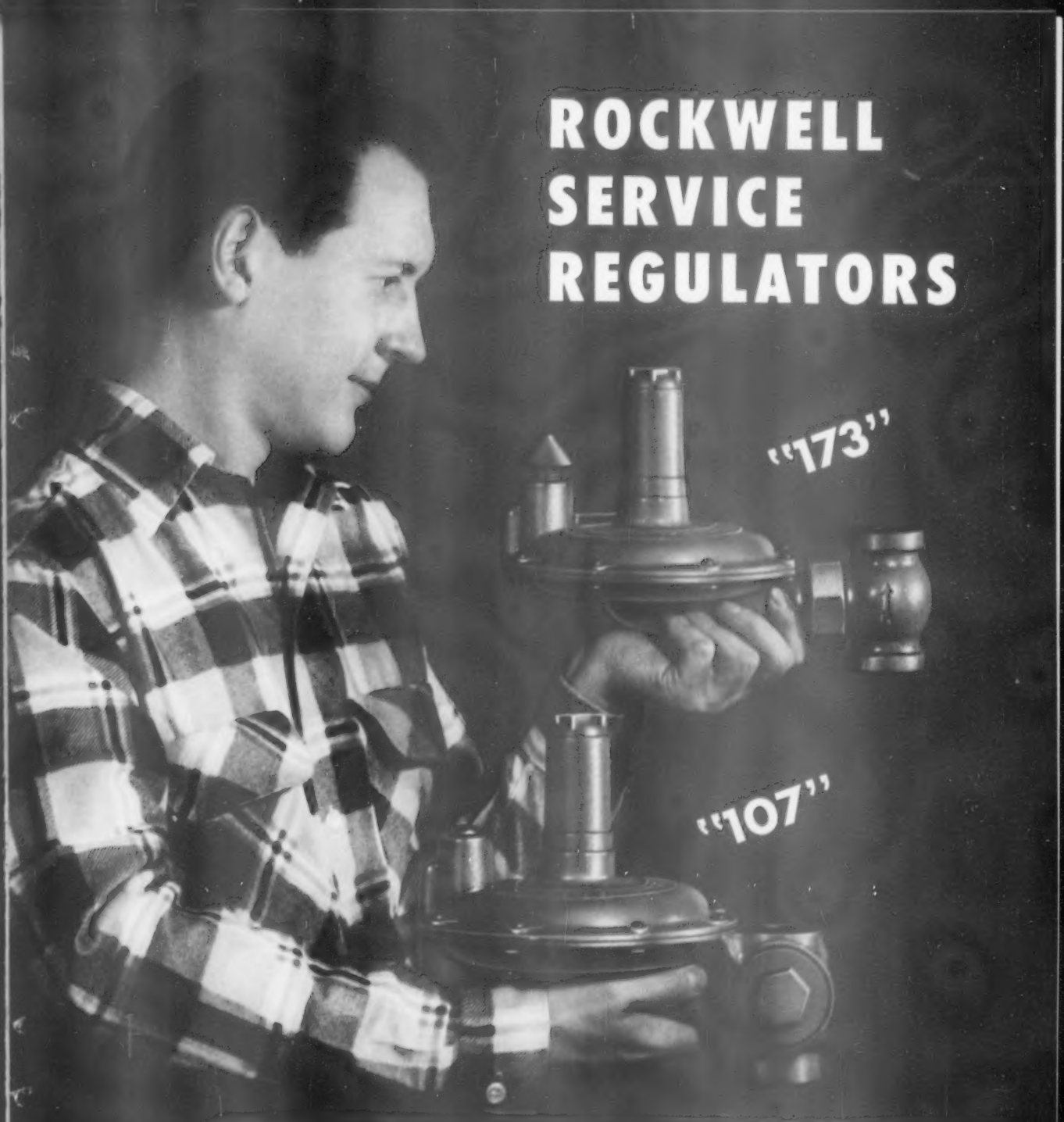
ALBERTA

Sun "A" 15-14 Pine, LSD 15, 14-31-22w4. Basal quartz gas well. TD 6,800 ft.

Baysel Unit 16-2 North Camrose, LSD 16, 2-47-20w4. Viking oil well. TD 3,320 ft.

BRITISH COLUMBIA

Hudson's Bay-Union 1 Milligan, unsurveyed. Triassic gas well. TD 5,985 ft.



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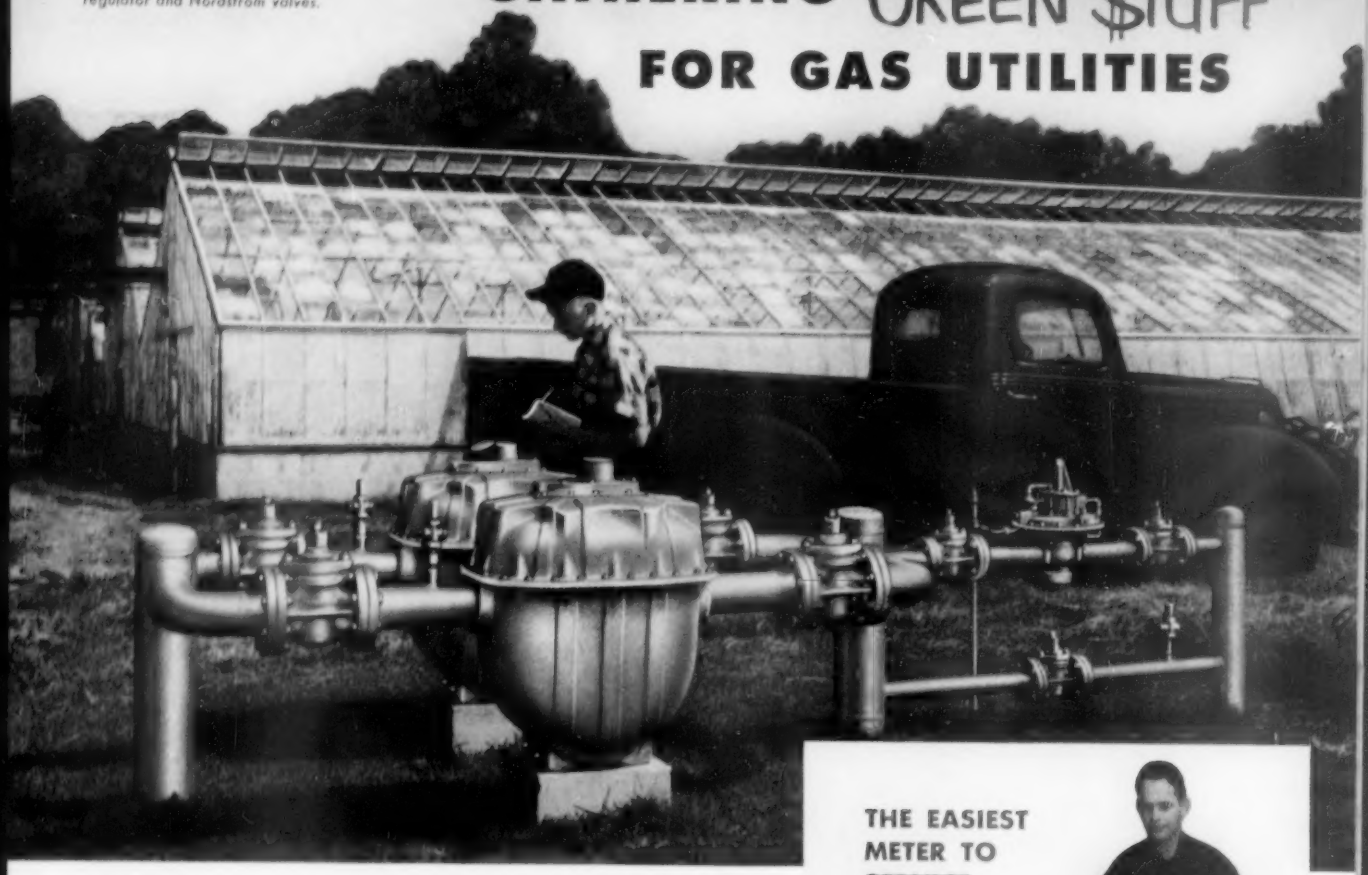

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Director Nominated

C. E. Spahr in line as new member of Sohio's board

STOCKHOLDERS of Standard Oil Co. (Ohio) late this month will elect three new men to the company's board of directors. One of the new directors almost surely will be Charles E. Spahr, boyish-looking executive vice president, whose 16 years' service makes him a relative newcomer among Sohio's top brass.

Spahr was elected executive vice president in February after serving several years as vice president for transportation. In his new assignment he will continue his role as assistant to Clyde T. Foster, Sohio president.

Both Foster and A. A. Stambaugh, chairman of Sohio's board of directors, have indicated that company management is backing Spahr for one of the new directorships.

Career . . . Spahr joined Sohio in 1939. During World War II, as an Army major, he supervised construction of a 570-mile pipeline in the India-Burma theater of operations.

His Army experience proved an asset. Soon after returning from the war, he started his quick-cadence march to the forefront of Sohio's management. He held various supervisory assignments in the company's transportation department before being promoted to vice president in 1950. A little later, he became assistant to the president.

Because of his varied pipeline experience in war and peace, Spahr recently was appointed by Secretary of Interior Douglas McKay to the Military Petroleum Advisory Board. He had served earlier, in 1952, as director of the supply and transportation division of the Petroleum Administration for Defense.

Family man . . . Spahr seldom lets company business interfere with his home life. "My main hobby is my family," says the prospective Sohio director. His three children—Sally, 13; Stephen, 7; and Cynthia, 1—keep his evening hours and weekends pretty well occupied.

"The differences in ages are such that each child's problems and interests are distinctly different. It's fun to turn from one to another and baffling at times, too . . .

"I like to sing to my small daughter. She likes it, too, not being very well educated in music yet."

Spahr also enjoys golf, "which I play quite badly but which affords me a great deal of exercise . . . about four times that of a good golfer . . ."

Unlike most Clevelanders, Spahr looks forward to the winter's first snowfall because he enjoys the exercise he gets in clearing the walks. He likes to wait, though, until the snow is pretty well packed before getting out the shovel. "One gets more exercise this way than by removing the stuff as soon as it falls," he explains.

Not all of Spahr's hobbies are so vigorous as chasing golf balls, shoveling snow, or playing with the youngsters.

"I like to fish in true lazy style with a straw hat pulled down over my face and a pole with static line hanging in the water." Sometimes, he admits, he purposely fails to bait the hook "so I won't be disturbed."

Spahr also spends much of his free time digging in his flower garden, tinkering in his woodwork shop, taking pictures of the kiddies, and reading. He describes himself as "a pretty good arm-chair traveler."

The future . . . Spahr moved in line as a potential director of Standard Oil Co. (Ohio) when the board voted recently in increase the number of directors from 7 to 10.

Additional places on the board are to be filled by stockholders at their annual meeting in Cleveland April 25.

R. A. Wilson has been appointed eastern district superintendent of producing operations in Illinois, Indiana, and Pennsylvania by the central division of Tide Water Associated Oil Co. Wilson will continue to be located at Robinson, Ill., where he has served as area superintendent for Tide Water since April 1945.

Francois de Gunzburg, executive vice president of Owanah Oil & Development Corp., has transferred his offices from Salt Lake City to Denver.

Graham W. Fenner has been promoted to the newly created position of division geophysicist for Continental Oil Co. He will make his headquarters at Ardmore, Okla., where he has been serving as geophysical supervisor for Conoco.

Albert E. Weightman has been named general manager of Tide Water Associated Oil Co. (Canada), Ltd. Weightman joined Tide Water in 1941.

JOE D. REID

Joe D. Reid, former vice president and operating manager of West Ohio Gas Co., has been elected president and general manager of the firm. Reid succeeds **George S. Vail,** who retired recently.

Edward H. Brown, formerly in the administrative department for Arabian American Oil Co. in Dhahran, Saudi Arabia, has been appointed general manager in the Middle East for Pacific Western Oil Corp. He succeeds **John Pochna,** who recently resigned.

Ben F. Rummerfield, vice president of Century Geophysical Corp., has won the annual best paper award of the Society of Exploration Geophysicists. His paper, "Reflection Quality, a Fourth Dimension," was selected by the society's honors and awards committee as the outstanding contribution to the advancement of exploration geophysics published in the quarterly journal of the S.E.G. during 1954. (The paper is being published in full by The Oil and Gas Journal starting on page 278 of this issue.)

Richard Dorn has resigned as president of Llano Drilling Co. of Midland effective April 1 to become manager of Forest Oil Corp.'s division office at Corpus Christi. His brother, **John Dorn,** former secretary-treasurer of Llano Drilling, also has resigned to become manager of Forest Oil's Permian basin division at Midland, replacing **Robert I. Dickey** whose recently announced

resignation from the company took effect April 1. Dickey also was a vice president of Forest. Both Richard and John Dorn will continue on with Llano as directors.

George Platt, formerly division reservoir engineer for Sinclair Oil & Gas Co. at Fort Worth, has resigned to join the Mercantile National Bank at Dallas as petroleum engineer in the bank's oil and gas department.

W. M. Rust, Jr., former chief of the geophysics research section of Humble Oil & Refining Co., has been named acting assistant chief geophysicist, a training assignment. Other training assignments announced by Humble include: **R. R. Thompson,** former assistant chief of geophysics research, named acting chief of the geophysics research section; **C. S. Fleischmann,** former acting staff geophysicist, appointed acting chief seismic section; **J. L. Patton,** former division geologist of the eastern exploration division, named division geologist of the East Texas division; and **W. C. Blackburn,** named to succeed Patton in charge of the Tallahassee, Fla., office.

Veteran Oil Writer Honored

Lt. Gen. Ernest O. Thompson, right, of the Texas Railroad Commission, presented N. D. (Bart) Bartlett two engraved silver trays on behalf of the petroleum industry at the annual banquet of the production division of the Mid-Continent district of American Petroleum Institute in Amarillo recently. Bartlett, dean of oil writers in the Southwest, was honored by seven industry associations for his work in writing about the oil business. He is oil editor of the Amarillo News and Globe-Times. Bartlett has been in the newspaper business 60 years.

A.P.I. Honors Five with Citations for Service

American Petroleum Institute honored five members of the oil industry at the Institute's recent spring meeting of the southwestern district of the division of production at New Orleans. A. W. Thompson, A.P.I. vice president for production, made the presentations. Men who were honored are, left to right, Floyd E. Hatfield, Gulf Oil Corp., Fort Worth; Paul L. DeVerter, Humble Oil & Refining Co., Baytown, Tex.; H. M. Harris (retired), Humble, Houston; Thompson; S. C. Oliphant, Tennessee Gas Transmission Co., Houston; and Drew Young, Atlantic Refining Co., Dallas.

Rex V. Phelps has been named manager of the newly formed terminal and transportation division of Warren Petroleum Corp. A graduate of the University of Oklahoma in general engineering, Phelps joined Warren in June 1940.

Harry P. Dreher, Jr., district engineer of the West Edmond Hunton Lime Unit at Edmond, Okla., for Sohio Petroleum Co., has been transferred to the firm's division office at Oklahoma City. **Paul G. Luckhardt,** district engineer of the Centralia, Ill., district, has been transferred to the Okmulgee, Okla., water-flood area as senior engineer.

N. N. Jones, district superintendent of Means district of West Texas division of Humble Oil & Refining Co., has been named area superintendent for the California area at Los Angels. Other promotions and transfers announced by Humble include: **Fred B. VanShoubroucek,** tool pusher of the Odessa district, named assistant superintendent at Snyder, Tex.; **W. E. Diamond,** tool pusher in the Grand Isle district, Louisiana division, named assistant district superintendent of the Paradis, La., district; **J. M. Shepherd,** district superintendent of the Bakersfield, Calif., area, transferred to Means district, West Texas division; **J. F. Jeansonne,** former assistant district superintendent at Wink district of West Texas division, succeeds Shepherd at Bakersfield; **J. P. Baldridge,** assistant superintendent of Snyder district of West Texas division, succeeds Jeansonne at Wink; **D. C. Rhodes,** district superintendent of Goose Creek district of the Gulf Coast division, promoted to assistant division superintendent of the Gulf Coast division.

Louis G. Morales, former assistant exploration manager of International Petroleum (Colombia) Ltd., has joined the staff of the Brazilian state company, Petrobras, as exploration manager. He will work with **Walter Link,** who recently resigned as exploration advisor to International Petroleum to take charge of Petrobras exploration. Link and Morales both signed 5-year contracts.

James H. (Jim) Murray has resigned his position as proration engineer with the Texas Railroad Commission and has opened consulting offices in Austin. He served with the state agency since 1951 and was in charge of West Texas fields. He will specialize in representation of operators before the commission.

J. W. LaBoon has been named manager of Shell Pipe Line Corp.'s communications department with headquarters in Houston. He succeeds **F. W. Littell,** who has retired. LaBoon, a veteran of 26 years with Shell Pipe Line, has been serving as area communications superintendent in Tulsa for the past 8 years. Littell, who has served

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PERSONALS

Shell for 35 years, was a pioneer in the development of the petroleum industry's radio service. **R. V. Herman** has been appointed to succeed LaBoon in Tulsa.

William F. Grote has joined Lion Oil Co. as geologist for the Salt Lake City district office.

Daniel J. Jones, Kentucky state geologist, has been elected president of the Association of American State Geologists. He succeeds **Charles F. Deiss** of the Indiana State Geological Survey.

George H. Colvin, former engineer trainee with Magnolia Petroleum Co. at Kermit, Tex., and Duncan, Okla., has been named junior petroleum engineer and transferred to Morgan City, La.

William M. Kearley, Jr., has joined TXL Oil Corp. at Midland, Tex., as a petroleum engineer. Before going with TXL, he had been serving as an engineer with Ohio Oil Co. at Hobbs, N. M.

Dr. Leendert de Witte has opened petroleum consulting offices at Laguna Beach, Calif. He will specialize in exploration, well surveying, production, and operations analyses. The author of numerous petroleum engineering papers, de Witte received his doctorate from California Institute of Technology in geophysics and petroleum geology. He was recently employed by Continental Oil Co. in petroleum production research.

Sam Z. Hall, former geologist with Magnolia Petroleum Co. at Roswell, N.M., has joined Geo. S. Anderson Co. at Fort Worth.

Wayne Hurt has joined Texas Pacific Coal & Oil Co. as assistant district geologist at Calgary. Hurt has been in Canada 4 years. He first was employed by Canadian Delhi Oil, Ltd., and later was a consultant with American Oil Management, Ltd.

George C. Hardin has been named office manager at Houston for the new uranium-vanadium-thorium exploration and production department of Michael T. Halbouty. **Dr. Daniel S. Turner,** former exploration geologist with the United States Atomic Energy Commission, has been named field manager.

Jack R. Price, geologist with General Petroleum Corp., has been transferred from Vernal, Utah, to Elko, Nev.

Ivan R. Cunningham, former assistant to the coordinator of production of Standard Oil Co. (N.J.), has been named a director and vice president of International Petroleum Co., Ltd.

T. C. Banta has been named vice president and a director of Sinclair Refining Co. and director of purchases of the subsidiary companies of Sinclair Oil Corp. Banta, who joined Sinclair in 1930 as a member of the central engineering department at the East Chicago, Ind., refinery, transferred to the purchasing department in New York in 1938. He was named purchasing agent in 1950.

William J. Troeller, Jr., has been promoted to section head in the products research division of Esso Research & Development Co. Troeller will be in charge of the analytical laboratories.

George B. Holden has been appointed director of the Arkansas Oil and Gas Commission. Holden succeeds **P. M. McLaughlin,** who resigned February 1. Holden has been serving the Louisiana government the past 5 years.

L. C. BORELL

L. C. Borell has been named manager of the Franklin, Pa., refinery of L. Sonneborn Sons, Inc., New York. Borell, former technical director of the refinery, succeeds **Charles H. Goss,** who retired recently. Borell joined the Sonneborn organization in 1932 as a research chemist.

E. Joe Pruitt has been named district geologist for the newly opened offices of D. D. Feldman Oil & Gas Co. at Corpus Christi, Tex. Pruitt formerly served with Lion Oil Co. and Skelly Oil Co. at Corpus Christi.

John G. Walmsley has been promoted to mechanical engineer in the maintenance department of the engineering division by Humble Oil & Refining Co. at its Baytown, Tex., refinery. Walmsley joined Humble in 1947. He will be in charge of testing pumps, compressors, and other mechanical equipment and recommending maintenance and changes.

Jack Tarner of Phillips Petroleum Co., Bartlesville, Okla., has been named chairman of the Mid-Continent district of the Production Division of American Petroleum Institute. Other officers elected by the group are: **E. R. Young,** Sohio Petroleum Co., Oklahoma City, vice chairman for Seminole-Oklahoma City area; **J. Clifford McClure,** Cities Service Oil Co., Great Bend, Kans., vice chairman for Kansas; **G. G. McKenney,** Dowell Incorporated, Cushing, Okla., vice chairman for the Drumright-Perry area; **Charles Galloup,** Natural Gas Pipeline Co. of America, vice chairman for Texas Panhandle; **Bliss Adamson,** Halliburton Oil Well Cementing Co., Duncan, Okla., vice chairman for southwestern Oklahoma; **Ben LaLonde,** Phillips, Pauls Valley, Okla., vice chairman for Golden Trend area; **Jake Easton,** National Tube Co., Wichita, secretary-treasurer; and **Fred J. Neslage,** West Pampa Repressuring Association, Pampa, Tex., chairman of the district advisory committee.

DEATHS

William A. Goforth, 77, founder and former president of Valley Osage Oil Co., died recently at Tulsa. He retired in 1948 after selling the company.

Rex L. Brown, 50, chief chemist of Imperial Oil, Ltd.'s, Regina refinery, died there recently. Brown joined Imperial in 1928 at its Ioco, British Columbia, refinery.

Arthur C. Wright, 52, crude-oil representative for Shell Oil Co.'s Denver office, died recently in New Orleans. Wright joined Shell in 1924 in the Los Angeles area.

Nathaniel Trahan, 65, retired foreman in the production department of Union Sulphur & Oil Co., died recently in Lake Charles after a short illness.

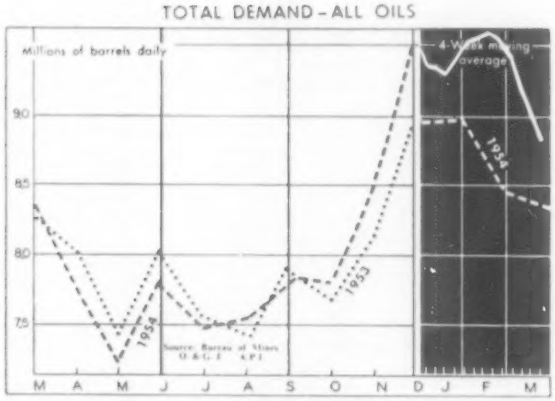
Auguste Jean Paris, Jr., 81, who was honored for his research in natural gas during World War I, died recently in a Bradford, Pa., hospital. Paris developed a process for getting natural gasoline from natural gas at the turn of the century. During the war he operated an experimental station at Charleston, W. V., for extracting aviation gasoline from natural gas.

Latest Figures . . . Industry Trends

A QUICK LOOK AT THE HIGHLIGHTS

	LATEST WEEK	Change from WEEK AGO		Change from YEAR AGO	
Production	6,849,550	UP	14,850	UP	351,040
Crude stocks	261,719,000	UP	1,175,000	DOWN	2,179,000
Completions	1,139	UP	97	UP	160
Refinery runs	7,334,000	DOWN	140,000	UP	334,000
Gasoline stocks	184,157,000	UP	317,000	UP	5,531,000
Distillate stocks	62,657,000	DOWN	1,078,000	UP	2,003,000
Four-product stocks	311,754,000	UP	325,000	UP	10,581,000
Total imports	1,208,700	DOWN	237,500	UP	147,900

TOTAL DEMAND – ALL OILS



Demand for Crude Will Reach the Low Point for the Year in April

REFINERS always charge less crude to stills in April than in any other month of the year. The only postwar exception to this rule was in 1952 when the strike closed part of the refineries in May.

If the abnormal year 1952 is omitted, postwar April runs have averaged 3.3 per cent less than runs in the first quarter. Preliminary A.P.I. reports for most of the first quarter of this year show refinery runs averaging about 7,430,000 bbl. daily. If the normal drop comes this month, refinery runs will be off almost 240,000 bbl. from the first-quarter average.

The April cut in crude runs is necessary because demand for products always takes a sharp drop in April. For the postwar period total demand in April has been 6.0 per cent less than demand in the first quarter. The drop will be even larger this year. If April demand is up 6 per cent over April 1954, it still will be 10 per cent less than demand in the first quarter.

With April demand at least 900,000 bbl. daily less than in the first quarter, refiners will need to make a bigger cut in runs than the normal 240,000 bbl. daily.

If refiners reduce runs in April to about 7,100,000 bbl. daily, crude stocks will gain at least 10 million barrels during the month. Production rates for April are expected to be only about 40,000 bbl. daily less than for March, based on changes in allowables. Importing companies forecast crude imports for April at 700,000 bbl. daily or 30,000 bbl. daily less than March. Total crude supply will be off not more than 70,000 bbl. daily. Crude runs should be cut at least 350,000 bbl. daily.

Group 3 gasoline markets are firmer . . . Higher prices for gasoline in Oklahoma may be an indicator of higher quotations for Group 3 gasoline moving to North Central area.

Formal quotation for Group 3 gasoline, moving to the North, is 10.75 cents a gallon for regular. However, actual spot sales haven't moved at that price since January 1954. For most of the period since that time, regular gasoline on the spot market has sold for at least 0.5 cent less than the 10.75 quotation.

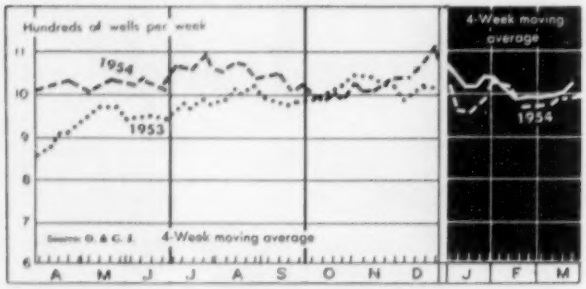
Pipeline specifications for both regular and premium gasoline were raised in March. Higher-quality gasoline means increased costs for the refiner. The only way the refiner can recover this increase in processing cost is through higher prices for the products.

Increases in gasoline prices have shown up in the form of higher tank-wagon prices in Oklahoma and higher quotations for local deliveries by tank car or tank truck.

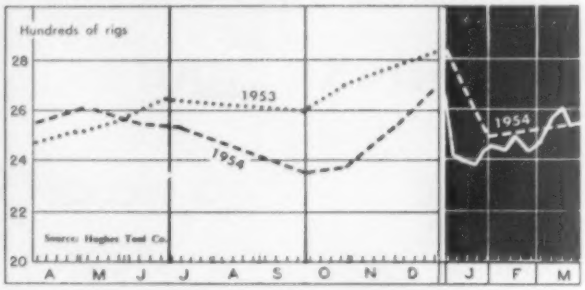
Since the higher-quality gasoline will be at most pipeline terminals by the end of the first week of April, some suppliers are predicting increases in Group 3 quotations before the middle of the month.

The refiner still has a little price problem. Spot prices may move up 0.25 cent a gallon, but they still would be 0.25 cent below the old formal quotation of 10.75 cents. If the formal quotation is moved up 0.25 cent, the half-cent differential will still exist between the spot price and the base quotation for calculating some contract prices.

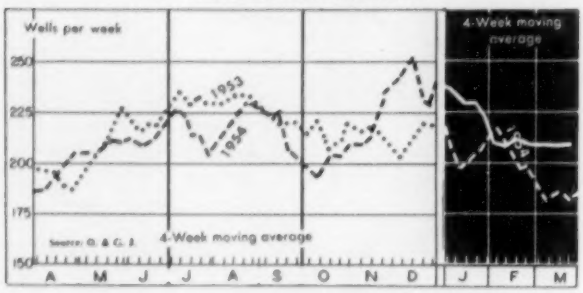
TOTAL COMPLETIONS



ROTARY RIGS OPERATING IN UNITED STATES



WILDCAT COMPLETIONS



ACTIVE ROTARY RIGS*

Area—	3-28-55	Change from 3-21-55	Change from 3-29-54
Gulf Coast	563	—18	31
N. and W. Texas-New Mexico	846	—14	75
Arkansas-N. Louisiana-E. Texas	169	—8	—8
Oklahoma	281	—35	—102
Kansas-S. Nebraska	191	4	43
Illinois-Eastern	109	—18	—22
Rocky Mountain	212	16	—13
Pacific Coast	160	2	20
Total United States	2,531	—71	24
Western Canada	201	5	54

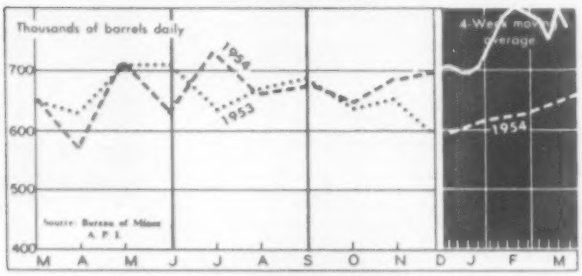
*Hughes Tool Co.

WEEKLY WELL COMPLETIONS . . .WEEK ENDED MARCH 26, 1955

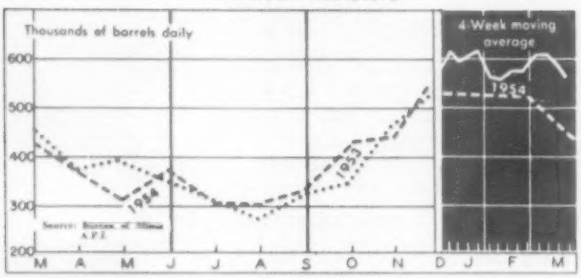
	Total of all wells: Comp.	Oil	Gas	Dry	Footage	Cum. 1955	Cum. 1954	Wildcat completions and discoveries: Oil	Dist.	Gas	Dry	Total	Cumulative total, 1955: Oil	Dist.	Gas	Dry	Total
Ala.-Ga.-Fla.	1	0	0	1	3,922	27	29	0	0	0	1	1	0	0	0	26	26
Arkansas	10	5	0	5	30,409	122	142	1	0	0	0	1	8	0	0	31	39
California	51	43	1	7	245,537	554	580	1	0	0	0	1	8	0	1	78	87
Colorado	24	5	2	17	135,625	292	254	1	0	2	10	13	10	0	8	142	160
Illinois	55	32	0	23	133,561	816	576	0	0	0	5	5	12	0	0	98	110
Indiana	38	3	0	35	57,451	178	192	1	0	0	32	33	4	0	0	84	88
Kansas	100	62	4	34	358,573	1,148	965	1	0	1	14	16	33	1	8	183	225
Kentucky	21	8	5	8	42,727	294	247	0	0	0	5	5	9	0	2	51	62
Louisiana	90	64	6	20	603,592	881	731	5	3	0	4	12	30	17	8	80	135
North	42	33	2	7	121,684	462	359	2	0	0	1	3	5	2	1	34	42
South	48	31	4	13	481,908	419	372	3	3	0	3	9	25	15	7	46	93
Michigan	12	6	0	6	33,009	131	141	1	0	0	4	5	3	0	0	49	52
Mississippi	12	6	0	6	85,779	106	77	1	0	0	4	5	2	0	0	41	43
Montana	2	0	0	2	11,663	85	63	0	0	0	1	1	1	0	1	26	28
Nebraska	9	3	0	6	51,142	132	83	0	0	0	4	4	7	0	0	62	69
New Mexico	22	18	0	4	104,074	284	293	1	0	0	1	2	10	1	0	21	32
Northwest	4	2	0	2	12,352	75	83	0	0	0	1	1	1	0	0	5	6
Southeast	18	16	0	2	91,722	209	210	1	0	0	0	1	9	1	0	16	26
North Dakota	3	1	0	2	20,082	45	48	0	0	0	1	1	0	0	0	7	7
Ohio	21	11	4	6	45,837	243	252	0	0	0	0	0	0	0	2	5	7
Oklahoma	228	132	12	*84	612,689	1,854	2,102	3	2	5	10	20	34	7	10	134	185
Pennsylvania-New York	24	7	7	†10	61,537	378	564	0	0	0	0	0	0	0	4	3	7
Texas	390	246	8	136	1,710,568	4,317	4,074	15	2	2	86	105	164	17	30	913	1,124
Southwest (1 & 4)	61	36	3	22	213,411	688	576	3	0	0	16	19	23	6	10	176	215
Gulf Coast (2 & 3)	56	32	1	23	388,821	572	639	2	2	0	15	19	19	11	12	150	192
East (5 & 6)	18	4	2	12	89,297	240	183	1	0	1	9	11	8	0	1	77	86
North Central (7-B & 9)	148	88	0	60	449,321	1,526	1,533	7	0	0	33	40	83	0	0	352	435
West (7-C & 8)	86	66	1	19	495,337	1,058	948	1	0	0	13	14	30	0	4	154	188
Panhandle (10)	21	20	1	0	74,381	233	195	1	0	1	0	2	1	0	3	4	8
Utah	0	0	0	0	0	11	16	0	0	0	0	0	2	0	2	4	8
West Virginia	8	2	5	1	20,977	143	127	0	0	0	0	0	0	0	2	7	9
Wyoming	18	12	0	6	99,672	198	364	1	0	0	3	4	4	0	2	37	43
Miscellaneous	0	0	0	0	0	7	51	0	0	0	0	0	0	0	0	7	7
Total United States	**1,139**	**666**	54	419	4,468,426	12,246	11,971	32	7	10	185	**234**	341	43	80	2,089	2,553
Total previous week	1,042	607	79	356	4,117,288			24	4	9	169	206	309	36	70	1,904	2,319
Total March 27, 1954	979	574	54	351	3,865,658			20	2	1	148	171	325	37	75	2,000	2,437
Western Canada	38	21	1	16	182,133												

Service wells included: *19, †9.

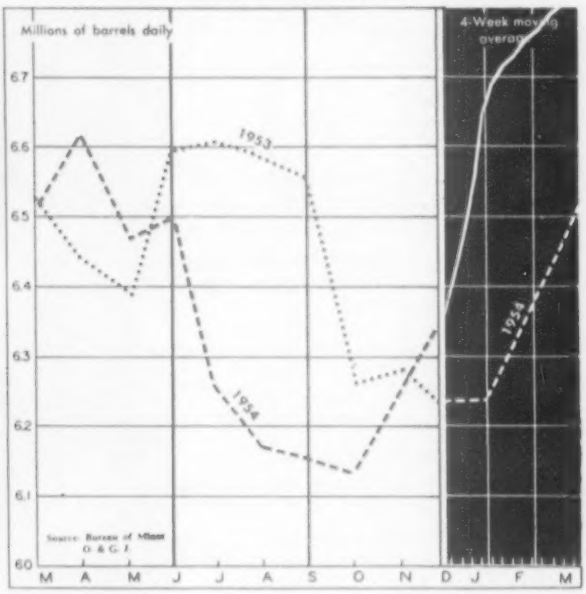
CRUDE IMPORTS



PRODUCT IMPORTS



CRUDE-OIL PRODUCTION

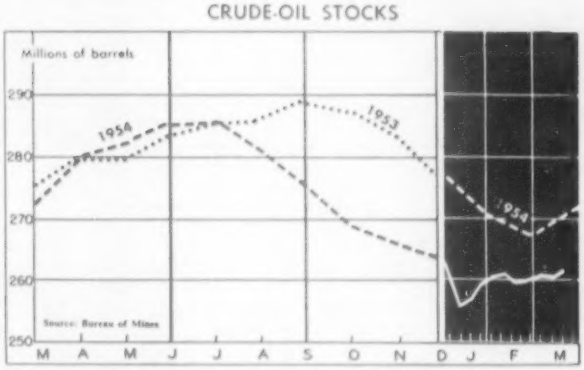


DAILY AVERAGE PRODUCTION FOR WEEK

	March 26 Crude oil	March 26 Lease condensate	March 26 Total	Mar. 19 total
Alabama	4,300		4,300	4,200
Arkansas	73,800	400	74,200	73,200
California	970,700		970,700	971,100
Colorado	140,100		140,100	138,300
Eastern	48,500		48,500	48,500
Florida	1,400		1,400	1,400
Illinois	211,400		211,400	211,900
Indiana	27,200		27,200	27,700
Kansas	338,200		338,200	339,200
Kentucky	38,700		38,700	38,800
Louisiana	660,700	53,250	713,950	711,500
North	110,200	3,250	113,450	111,000
South	550,500	50,000	600,500	600,500
Michigan	31,500		31,500	33,400
Mississippi	90,750	5,000	95,750	95,750
Montana	42,600		42,600	42,900
Nebraska	28,400		28,400	28,700
New Mexico	224,050	4,450	228,500	228,200
North Dakota	28,100		28,100	27,800
Oklahoma	572,500		572,500	564,600
Texas	2,920,000	52,950	2,972,950	2,972,950
Dist. 1	51,000	600	51,600	51,600
Dist. 2	151,000	8,200	159,200	159,200
Dist. 3	455,000	24,675	479,675	479,675
Dist. 4	258,000	5,900	263,900	263,900
Dist. 5	49,000	525	49,525	49,525
Dist. 6	127,000	5,675	132,675	132,675
East Texas field	237,500		237,500	237,500
Dist. 7-B	143,000	50	143,050	143,050
Dist. 7-C	190,000	4,600	194,600	194,600
Dist. 8	976,000	2,025	978,025	978,025
Dist. 9	195,000	650	195,650	195,650
Dist. 10	87,500	50	87,550	87,550
Utah	6,200		6,200	4,100
Wyoming	274,100		274,100	270,200
Others	‡300		‡300	300
Total U. S.	6,733,500	116,050	**6,849,550**	6,834,700
Change from previous week, up			**14,850**	
Canada	†308,400		†308,400	†334,775
Total U. S. production January 1-March 26			572,902,525 bbl.	
Same period last year (crude plus cond.)			*541,046,160 bbl.	

*Includes 8,829,725 bbl. condensate. †Week ended previous Monday. ‡Incl. S. D. 100, Nev. 200.

CRUDE-OIL STOCKS



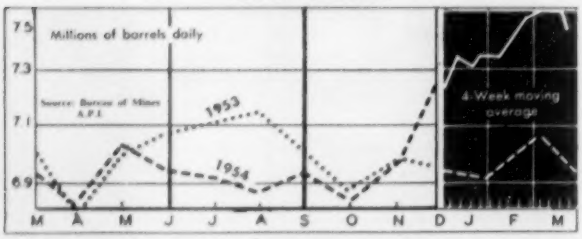
CRUDE-OIL STOCKS BY STATES OF ORIGIN*

(Thousands of barrels)

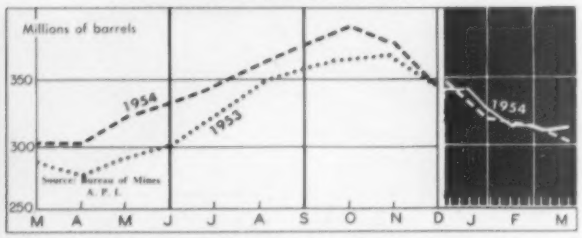
	Mar. 19, '55	Mar. 12, '55	Mar. 20, '54
Pennsylvania Grade	2,871	2,832	2,740
Other Appalachian	1,885	1,788	1,775
Illinois, Indiana, Michigan	10,802	10,902	11,827
Nebraska, North Dakota	1,557	1,599	(1)
Kansas	8,657	8,339	10,324
Oklahoma	24,070	24,508	26,331
Arkansas	2,757	3,077	3,050
Louisiana	14,775	14,534	14,675
North	2,464	2,550	2,537
South	12,311	11,984	12,138
Mississippi	3,060	3,061	3,304
New Mexico	8,246	8,160	7,254
Texas	119,145	118,729	120,540
East Texas proper	9,778	10,226	11,187
West Texas	52,345	51,273	51,578
Texas Gulf	23,203	23,565	25,256
Other Texas	33,819	33,665	32,519
Wyoming	13,748	13,951	13,705
Other Rocky Mountain	5,279	5,382	3,215
California	32,702	32,225	34,439
Foreign	†12,165	11,457	10,719
Total	261,719	260,544	263,898

*Bureau of Mines. †Includes 2,955,000 bbl. in California. ‡Included with Kansas.

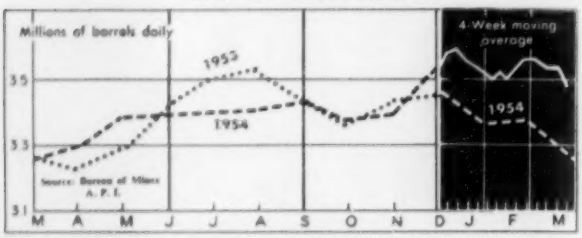
REFINERY RUNS



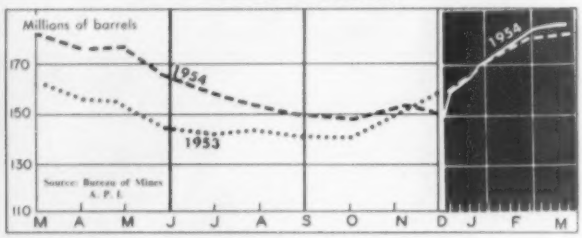
FOUR-PRODUCT STOCKS



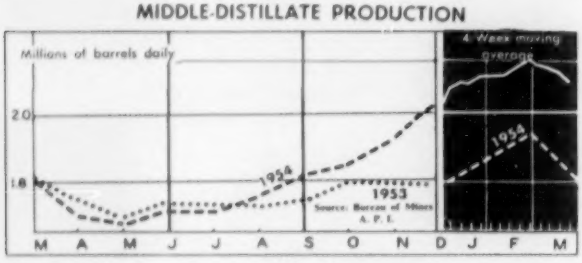
GASOLINE PRODUCTION



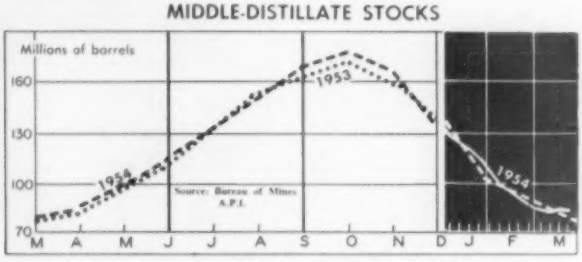
GASOLINE STOCKS



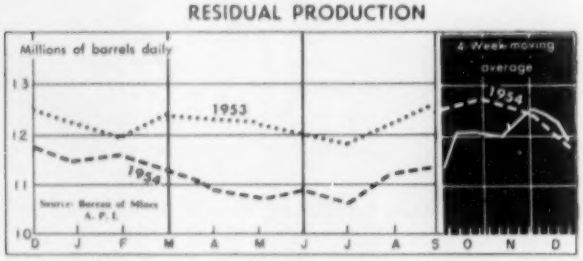
MIDDLE-DISTILLATE PRODUCTION



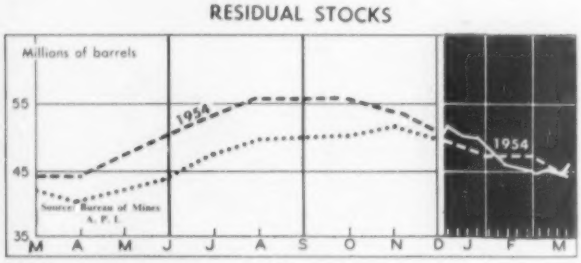
MIDDLE-DISTILLATE STOCKS



RESIDUAL PRODUCTION



RESIDUAL STOCKS



A.P.I. REFINERY REPORT, MARCH 25

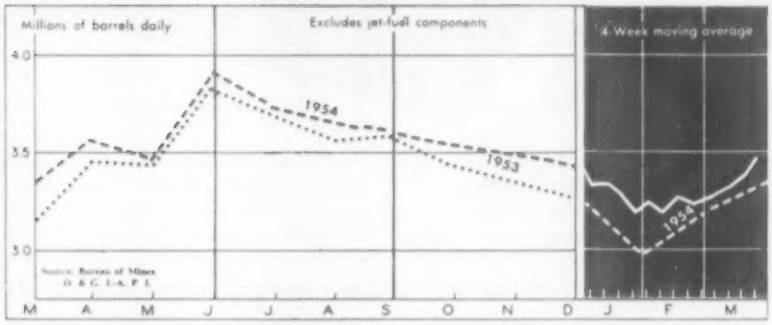
(Excludes all jet-fuel components)

(Thousands of barrels)

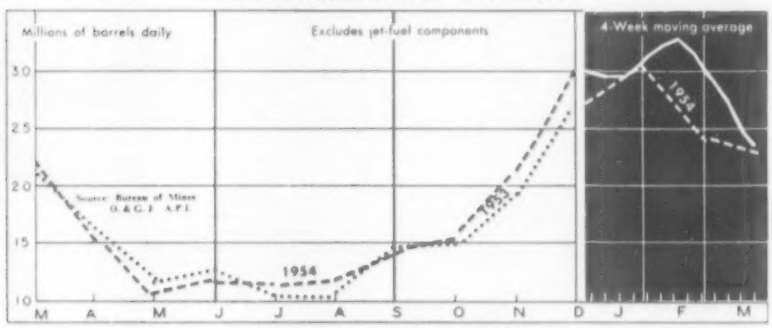
District—	Daily avg. runs	Daily average production—Gaso.*	Kero.	Dist.	Resid.	Stocks‡—Gaso.†	Kero.	Dist.	Resid.	Bureau of Mines, March 1954—Daily avg. runs	Daily average production—Gaso.*	Kero.	Dist.	Resid.
East Coast	1,090	388.9	25.8	254.9	191.4	36,763	8,254	22,714	8,765	1,021	410.7	32.1	256.3	212.1
Appalachian:														
District 1	97	39.9	5.6	23.6	8.0	4,924	510	1,491	270	100	41.7	5.3	21.4	12.9
District 2	100	49.1	9.6	19.4	13.7	2,510	292	653	149	94	47.9	6.6	17.2	14.4
Ind., Ill., Ky.	1,377	670.6	75.8	275.1	187.0	40,978	4,377	10,028	3,252	1,274	662.6	73.3	240.3	175.4
Okla., Kans., Mo.	610	335.7	17.7	158.6	36.6	20,019	860	6,272	972	582	335.3	16.6	133.4	44.1
Inland Texas	249	175.7	9.6	45.3	22.4	6,727	344	1,116	1,287	244	167.0	10.5	43.0	27.8
Texas Gulf Coast	1,815	820.7	113.7	488.1	250.5	25,699	1,785	6,020	4,473	1,694	760.7	141.9	383.9	230.8
La. Gulf Coast	635	307.4	44.0	170.7	37.4	11,946	1,209	2,659	1,456	559	246.4	45.7	143.2	45.2
N. La. and Ark.	83	32.7	8.6	23.0	6.0	4,493	745	1,006	136	90	36.8	8.6	21.6	7.0
Rocky Mountain:														
New Mexico	18	9.9	1.0	2.6	2.7	145		80	30	19	12.2	0.8	3.2	2.5
Other Rocky Mtn.	251	118.7	3.7	65.3	40.6	8,561	186	1,943	678	234	110.8	3.7	54.2	40.0
California	1,009	449.0		156.0	353.6	21,392	328	8,675	24,582	1,012	428.9	7.9	140.5	356.3
Mar. 25, 1955	7,334	3,398.3	315.1	1,682.6	1,149.9	184,157	18,890	62,657	46,050	6,923	3,261.0	353.0	1,458.2	1,168.5
Mar. 18, 1955	7,474	3,491.9	400.1	1,696.0	1,219.7	183,840	19,053	63,735	44,801					
Mar. 26, 1954	7,000	3,372.4	346.3	1,455.0	1,195.9	178,626	17,800	60,654	44,093					

*At refineries including natural blended. †Finished and unfinished. ‡At refineries, bulk terminals, in transit, and in pipelines.

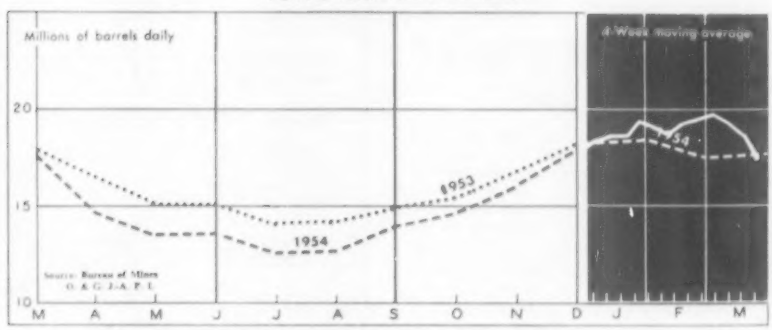
TOTAL GASOLINE DEMAND


Millions of barrels daily
Excludes jet-fuel components
4-Week moving average
1954
1953
Source: Bureau of Mines
O. & G. J.-A. P. I.
M A M J J A S O N D J F M

TOTAL MIDDLE-DISTILLATE DEMAND


Millions of barrels daily
Excludes jet-fuel components
4-Week moving average
1954
1953
Source: Bureau of Mines
O. & G. J.-A. P. I.
M A M J J A S O N D J F M

TOTAL RESIDUAL DEMAND



REPRESENTATIVE QUOTATIONS

Spot-market quotations of leading suppliers as of March 30, 1955. Prices are in cents per gallon, except for residual in dollars per barrel and wax in cents per pound.

GASOLINE, KEROSINE, AND FUEL OILS

	Mid-Continent Group 3	New York Harbor (barge)	Texas Gulf Coast
Regular gasoline	10.25-11	11.25-12	10.25-10.75
Premium gasoline	11.25-12	13-13.75	11.50-11.75
42-44 w.w. kerosine	9.5-9.75	10.6-10.7	9.5-9.75
No. 2 straw fuel oil	8.75-9.0	9.95	8.75-9.0
No. 6 residual	$1.50-1.60	$2.30-2.45	$1.95-2.00

NATURAL GASOLINE

	Group 3	North Texas	N. La.
Grade 26-70	4.5	4.0	4.25
Grade 18-55	5.4	4.9	5.15

LUBRICATING OILS

Mid-Continent

150-160 vis., D bright stock, 0-10 pp.	18
200 vis., No. 3 neutral, 0-10 pp.	13.25

WAX

Mid-Continent

132-134 A.M.P.	6.0

● Seasonal decreases in demand for light heating oils on the Gulf Coast caused a drop of 0.25 cent a gallon in the low quotation for No. 2 fuel in cargo lots. The reduction of 0.25 cent for regular gasoline on the Gulf Coast represents shading of the general posting. Group 3 gasoline has a firmer tone.

PRODUCTION AND DEMAND—MAJOR PRODUCTS

(Thousands of barrels daily)

	Refinery prod.	Total demand
Gasoline:		
Four weeks ended 3-25-55	3,478	3,484
December 1954	3,605	3,455
February 1954	3,365	3,182
March 1954	3,261	3,331
Middle distillate:		
Four weeks ended 3-25-55	2,103	2,330
December 1954	2,049	3,112
February 1954	1,957	2,413
March 1954	1,811	2,235
Residual fuel:		
Four weeks ended 3-25-55	1,192	1,736
December 1954	1,187	1,819
February 1954	1,241	1,742
March 1954	1,169	1,664

CRUDE PRICES

GRAVITY SCHEDULE

	Signal Hill, Calif.*	Okla-homa, Kansas	Gulf Coast Tex.†	West Texas‡
14-14.9	$1.87			
15-15.9	1.93			
16-16.9	1.99			
17-17.9	2.05			
18-18.9	2.11			
19-19.9	2.18			
20-20.9	2.24	$2.50		$2.37
21-21.9	2.30	2.52		2.39
22-22.9	2.37	2.54		2.41
23-23.9	2.45	2.56		2.43
24-24.9	2.53	2.58	$2.91	2.45
25-25.9	2.61	2.60	2.93	2.47
26-26.9	2.69	2.62	2.95	2.49
27-27.9	2.76	2.64	2.97	2.51
28-28.9	2.83	2.66	2.99	2.53
29-29.9	2.91	2.68	3.01	2.55
30-30.9	2.97	2.70	3.03	2.57
31-31.9	3.04	2.72	3.05	2.59
32-32.9	3.12	2.74	3.07	2.61
33-33.9		2.76	3.09	2.63
34-34.9		2.78	3.11	2.65
35-35.9		2.80	3.13	2.67
36-36.9		2.82	3.15	2.69
37-37.9		2.84	3.17	2.71
38-38.9		2.86	3.19	2.73
39-39.9		2.88	3.21	2.75
40 and above		2.90	3.23	2.77

*Standard Oil Co. of California. †Upper Texas Gulf Coast. ‡Sour. Includes New Mexico Permian.

Effective dates: California, February 16, 1953; east of California, June 15, 1953; Pennsylvania Grade, January 21, 1955.

FLAT CRUDE PRICES

Representative posted schedules per barrel

Louisiana:	
Cotton Valley (distillate)	$3.00
Cotton Valley (Holloway crude)	2.95
Texas:	
East Texas	2.90
Chapel Hill	2.83
Conroe	3.13
Van	2.73
Pennsylvania Grade:	
Bradford	3.50
Middle District	3.37
Southwest Pennsylvania	3.08
West Virginia	2.97
Buckeye Grade	2.91
Zanesville Grade	2.72
Illinois Basin	2.90

CLASSIFIED ADVERTISING

Your MARKET PLACE FOR THE OIL AND GAS INDUSTRY...

UNDISPLAYED CLASSIFIED 23c a word one issue. 10% Discount three or more consecutive issues. $4.00 minimum charge. Blind Box in our care nine words. Payable in Advance.

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$16.00 a column inch one issue . . .
10% Discount three or more issues.

Address Classified Advertising Material: The Oil and Gas Journal, P. O. Box 1260, Tulsa 1, Okla.

FOR SALE EQUIPMENT

FOR SALE—in Seminole area 6—10' x 40' riveted and welded horizontal gasolene storage tanks. Cities Service Oil. Patridge, Bartlesville, Oklahoma.

CORE DRILLS, SPUDDERS, ROTARIES: New and used equipment. Everything in supplies. Fishing tools rented. Pressey & Son, Pueblo, Colo.

FOR SALE: ENGINE—165 Hp. Climax Model R61, maximum continuous Hp. rating 126. Herndon Drilling Company, 421 Mayo Building, Tulsa. Phone 4-9700.

111 JOINTS 4½" 16.6# weight drill pipe, Spang Shrink Grip. Has drilled 40,000'. Selling account estate. Price $2.10 per foot, stored Tulsa area. No brokers, no commissions. Ray Hose, Hotel Capitol, Springfield, Illinois.

BUCYRUS-ERIE Spudder—36 L. Buda engine, butane equipped. Auxiliary leg. Tools from 15½" to 5". Completely equipped and ready to drill. Inventory furnished upon request. Robert J. Orr, 1928 Crestview Dr., Bartlesville, Okla. Phone 5427.

FOR SALE: 1—Beaird—Ingersoll-Rand packaged Compressor Plant, Type 6-JVG (165 H.P.) Heavy Duty, direct connected, 4-cycle, gas engine driven, single stage equipped with 3—4¼ x 9 compressor cylinders, three hand operated fixed volume pockets, two hand operated valve lifters, 20" O.D. 500# W.P. intake scrubber, air starting equipment and controls for automatic operation. Designed for intake pressure range 100#-250#, discharge pressure range 500#-600#. Delivery 3,480 MCF per day at 250# intake, 550# discharge. This plant has been in use less than 30 days and is located near Palestine, Texas. Box H-616, The Oil and Gas Journal, Tulsa, Oklahoma.

Gaso Duplex 4½" x 6" Power Pumps with Chrysler C-36 Engines, skid mounted, immediate delivery. Also Byron Jackson, Carter Centrifugal Units. Westinghouse 20-25-50 KW Generating Units.

H. H. COFFIELD
Attn.: W. H. ORR
Phones: 132—Rockdale, Texas
AT-3427—Houston, Texas

USED EQUIPMENT

Franks Model 4000-TM Single Drum Well Servicing Units. Single Pole Past. Truck Mounted.

Franks Model Super East Texas Single Drum Well Servicing Unit. Truck Mounted. Handles 6500' work.

50/60 Ideco Skid Servicing Unit. Double Pole Mast. Mounted on International Tandem Truck.

O.C.S. Type 3 Servicing Unit mounted on 1942 Mack Truck. Located Odessa, Texas.

Write, Wire or Call

FRANKS MFG. CORPORATION
BOX 5218, WHITTIER STATION
TULSA, OKLAHOMA

FOR SALE EQUIPMENT

FOR SALE: Nearly new S 33 Walker-Neer Spudder. Box H-702, The Oil and Gas Journal, Tulsa, Oklahoma.

SALES AND RENTALS of Rotary and Cable tools. E. A. Kelly, Okla. City, 3125 S. E. 29th St. Box 861. JA 5-6407.

GAS METERS: Westcott and Foxboro Orifice Meters and Controllers. Bristol and Taylor Recording Pressure Gauges. GEO. R. MILNER, P. O. Box 124. OKMULGEE, OKLAHOMA.

FOR SALE: Two R. L. Cardwell Double Drum Spudders with derrick type masts. Would sell complete with Dog House, Light Plant, Wirelines, and Tools or with any part of them. Write Box 871, Seminole, Okla.

ROTARY RIG COMPLETE: 2,500 to 5,000 ft. capacity. Easily Portable. 4½-in. drill pipe. Double derrick, 7-ft. substructure, Model "S" Cardwell drawworks, 14-in. Gardner-Denver pump powered by LRO Waukesha. R. V. Dillard, Phone 1177 or write Box 992, Duncan, Okla.

GASOLINE PLANT *FOR SALE*

Gasoline Plant, located in Brazoria County, Texas, shut down in January, 1954. Had been processing approximately thirty-three million feet of gas daily with absorber pressure approximately six hundred thirty pounds. Plant recovered Propane, Butane, Gasoline, Kerosene and Diesel Oil. Detailed inventory available upon request.

SOUTHERN PRODUCTION CO., INC.
P. O. Box 670, Ft. Worth, Texas

ROTARY RIG FOR SALE

Consisting of Wilson Giant Drawworks, G.M.C. Diesel Engines, 7¼" x 14" Gardner-Denver Pump, L. C. Moore Portable Derrick, 5200' of 4½" F.H. Drill pipe, Dog Houses, Water Tanks and etc. Rig is complete with all tools and in very good condition to start drilling.

CONTACT

H. L. Herbel,

BOX 506.
CHASE, KANSAS.
Phone #LD43 or 196.

FOR SALE EQUIPMENT

SULLIVAN 200 complete with tools ready to work, located Tulsa, Oklahoma. Contact R. F. Mesker, 1129 E. 15th St., Phone 4-9483.

SALES and Rentals of cable drilling and fishing tools, casing and equipment, from the Southwest's largest stock of used cable tools and oil field supplies. Degen Pipe and Supply Co., Tulsa, Oklahoma.

N-4 BREWSTER Single Drum Drawworks with one WAK Waukesha Engine—Less than 3 years old—Excellent condition—$11,000.00 —Contact Dick Schriber, Iverson Supply Company, Phone 7-2349, Odessa, Texas.

AIRCRAFT PARTS & REPAIRS
Mr. Aircraft Owner: Take advantage of our extra special service and vast inventories of Parts, ENGINES, PROPELLERS, TIRES and Supplies. Domestic and Foreign shipments. C A A approved repair station No. 3846.

VESTCO
Dept. L, Box 5306 T A
Denver 17, Colo.

LIQUIDATION

GAS COMPRESSION RECYCLING PLANT

6—IR Type KVG Gas Engine Driven Compressors, 600 HP and 660 HP.

$50,000 of new spare parts for compressor.

2—IR starting air compressors. Model 25C Type 40, air cooled, 265# discharge pressure, 67.6 cfm, 25 HP. Xpl motor.

6—M. W. Kellogg, 2,400 sq. ft. heat exchangers 550—1" 14 gage, 16' long Admiralty tubes each.

3—150# drums; 10 x 20, 8 x 16, 6 x 20.

6—centrifugal pumps; 200 g.p.m. 90' hd., 60 g.p.m. 460' hd., 400 g.p.m., 290' hd.

WIRE! PHONE! WRITE!

LIQUIDATION LEVELLAND, TEX.

6 x 53 chlin tower, mfg. 1951

6'6" x 55', 6' x 27', 5' x 27', 42" x 49', 30" x 35' towers.

1600, (4) 500 Sq. Ft. ADM HT exchangers.

(2) 800 Sq. Ft. (675# 800° F.) St. Exchangers.

BJ 5-St. N. ch. pump, 400 g.p.m. 2100' hd.

5' x 38' 90# CHR Vessel.

Steel, chrome pipe, valves, fittings, etc.

AVAILABLE ELSEWHERE

7' x 26' SS, 7'6" x 56' towers.

(4) 424 sq. ft. ADM exchangers.

10—1500, 360, 260 sq. ft. St. Ht. exchangers.

3—RA-8, MA-4 Clark engines.

6—325# Vessels 10' x 35', 7' x 30', 4' x 40'.

Detailed circular upon request.

BRILL EQUIPMENT COMPANY

4101 San Jacinto St., Houston 4, Texas, Locust 1351
New York Office, 2401 Third Ave.,
Telephone Cypress 2-5703
Sell us your surplus equipment

FOR SALE EQUIPMENT

FOR SALE: Pipe threading machines; 18" Bignall-Keeler; 13" Bignall-Keeler with Landis head; 8" Williams plus 6" Williams head; and 2" Landis. Call or write Singer Supply Company, P. O. Box 1522, Oklahoma City, Phone REgent 6-8596.

FOR SALE—Horizontal Duplex Steam Pumps—10x8½x12—353 GPM—bronze fitted—max. discharge pressure 100 lbs.—6" suction—5" discharge—mfg. by American Marsh Co. Quantity available—NEW—Boston Metals Co. 313 E. Baltimore St., Baltimore 2, Md., Curtis 7-5050.

FOR SALE—In Oklahoma and Missouri 12 500 HP 4 cylinder Vertical Diesel engines and 5⅜" x 36" and 6¾" x 24" Horizontal Triplex Plunger Pumps fitted with steel fluid ends. Operational changes render surplus. Complete data upon request. Cities Service Oil Company, Patridge, Bartlesville, Oklahoma.

ROTARY. Heavy duty equipment. G-D Pump 7"x14", Johnson draw works, OWS 20" table, blocks, hooks, water swivel, Kelly, hose, tongs, steel dog-house. Good equipment. Send for complete listing and pictures. Price only $6250.00. Pressey & Son, Pueblo, Colo.

FOR SALE: Complete Seismograph Recording Truck and Shooting Truck. 24 trace Technical Instrument Co. (TICO) equipment mounted in SIE cab on Ford F-3 Truck with developing rack, power supply, etc. Equipment used 4 months. Excellent condition, like new. Priced to sell. A Ford F-6 Griffin Built, 400 gallon Shooting Truck complete, with powder storage, cap box, etc. Priced to sell. Send inquiries to Box H-717, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE

Large quantity 4" used steel line pipe, excellent condition, for immediate delivery by owner.

THE GORDON CO.
1514 Kanawha Blvd. East
Charleston, West Virginia
Telephone No. Dickens 4-1514

STEEL STORAGE TANKS

Only Eight Available

Vertical . . Good condition . . 11-0x17-0, 12,000 gallon capacity ¼" bottom; 3/16" shell; 12 gauge top . . one or more priced for quick sale.

BROWN-STRAUSS Corporation
1546 GUINOTTE KANSAS CITY, MO.
PHONE HA. 1999

FOR SALE EQUIPMENT

SPUDDER. Used Star #45 for 5000' drilling. Crawler mounted. 190 HP Waukesha engine. Good outfit for only $4250. Pressey & Son, Pueblo, Colo.

5000' OF USED 3½" OD full hole drill pipe, Range 2, in excellent condition at $1.00 per foot. A. A. Gilbert Pipe & Supply Company, P.O. Box 986, Shreveport, Louisiana.

FOR SALE: Gas Transmission Plant, daily capacity 800,000 cubic feet. Located in Creek County, Oklahoma. Contact L. A. Jarvis, Box 335 or Phone 4149, Konawa, Oklahoma, or Phone 1000, Bristow, Oklahoma.

FOR SALE, TRADE: 44OF Cyclone Drill. Write C. Tackett, Bokoshe, Okla. Phone 801F4.

THREE #12 Sweetland Filters, 48 bronze leaves, monel covered on 3" C-C, now located in southwest, available for inspection. 11 Sperry 18" x 18" cast iron Filter presses. 11 chambers. Consolidated Products Co. Inc. #65 Garden Street, Hoboken, N. J. N. Y. Tel.: BArclay 7-0600.

GAS COMPRESSORS: One 230 H.P. Clark, one 100 H.P. Superior, five type 80 Coopers, class 'B' Cooper cylinders, 300 lbs. Alfred B. Kern, 227 Wright Building, Tulsa 3, Oklahoma.

FOR SALE, at our Arkansas City, Kansas gasolene plant, 1—10' x 40' used horizontal riveted and welded gasolene storage tank, $850.00. Cities Service Oil, Patridge, Bartlesville, Okla.

FOR SALE, at our Button plant, Oklahoma City, one set of 14—12½" heat exchangers, which were originally a part of a Tulsa-type distillation unit. Price, as is, $1,500.00. Cities Service Oil, Patridge, Bartlesville, Okla.

STAR 45-C CABLE RIG in A-1 condition. 10-in. seamless A-mast; 1300 Caterpillar Diesel engine. 15-in. down to 4-in. Tools. Fully equipped. Rated capacity, 3,000 ft. Also have 5 to 600 ft. of 12-in., 1,000 ft. of 10-in., 1,600 ft. of 8-in. seamless casing. Located near Independence, Kansas. Box H-661, The Oil and Gas Journal, Tulsa, Oklahoma.

NEED A PIPE LINE

Have 800 Miles 8" Line Pipe

we are taking up through Illinois, Indiana, and Ohio. Will furnish pipe, go in on a deal, or finance.

We are open for any kind of deal.

REDNEB PIPE CO.
P. O. Box 1798 Shreveport, La.
Phone 2-3276

FOR SALE EQUIPMENT

3—200 HP S. H. CLARK Horz. Compressors equipped with 5—10 x 20 VSL and 1—8½ x 20 Type S Compressor Cylinders. Location near Kilgore, Texas. Also spare compressor cylinders at Tulsa, Okla. Nolan Sales Corp. 421 N. Cincinnati, Tulsa, Okla.

EQUIPMENT WANTED

WANTED—Rockwell—Emco Integrator. Must be in good condition and will compute all makes of orifice meter charts. Box H-715, The Oil and Gas Journal, Tulsa, Oklahoma.

(2) 17" COMPRESSORS lined to 13" to 14" complete with liners and pistons for Watts-Miller, Type 4, 225 H.P. Engine. Write Columbian Carbon Company, Box 873, Charleston, W. Va.

WANTED TO BUY

Good Used 12¾" O.D.—14" O.D. and 16" O.D. Line Pipe

CENTRAL PIPE & SUPPLY CO.
Box 1466. Phone SHerwood 4-7404
Lubbock, Texas

HELP WANTED

EXPERIENCED LANDMAN, under 35, needed for independent oil producer. State salary required. P. O. Box 2775, Dallas, Texas.

PETROLEUM ENGINEER. Must have varied experience in drilling, completion, and workovers for independent oil company in Illinois Basin. Give qualifications, references and salary expected in first reply. Box H-727, The Oil and Gas Journal, Tulsa, Oklahoma.

IMMEDIATE OPENING for process engineer with experience in operation and design of petroleum refining equipment. Refinery located in southwest. TCC catalytic cracking experience desirable. Write giving resume of experience, availability and salary desired. Box H-628, The Oil and Gas Journal, Tulsa, Oklahoma.

EXPERIENCED SEISMOGRAPH Party Chiefs and Seismologists by established contract Seismograph Company. Dallas organization. Salary commensurate with experience. Give full qualifications and references. Maximum Age 40. Box H-689, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEER OR GEOLOGIST

with broad general knowledge of the petroleum industry in East Texas, North Louisiana and South Arkansas to fill position with well established firm in area. State qualifications in detail.

Box H-705, The Oil and Gas Journal, Tulsa, Oklahoma.

STAFF ENGINEER

Major operator of gasoline plants has staff opening for qualified process, design and construction engineer. Requires supervisory experience and ability to direct major programs. Must have engineering degree with minimum of ten years experience in the field of gasoline plant design and construction. Salary commensurate with experience and qualifications. Age limit 40.

Send detailed personal and work history with photograph to

Box H-706, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE
EXCELLENT USED ROTARY RIGS

GA-500 EMSCO powered by three 6-NKU Waukesha Engines; 126' Oil Well Portable Mast with 10' Substructure; FX-FXQ Gardner-Denver 7¾"x16" Pump; Blowout Preventer, Steel Mud Pits; Vibrating Shale Shaker; Thyrite Generator; 7,000'—4½" Grade E Drill Pipe and complete accessories—located Southern Oklahoma.

GA-500 EMSCO powered by two V-85 Climax Engines; 136' Standard Derrick; FX-FXQ Gardner-Denver 7¾"x16" Pump; Blowout Preventer; Steel Mud Pits; Vibrating Shale Shaker; Thyrite Generator; 6800'—4½" Grade E Drill Pipe and complete accessories—located Central Oklahoma.

Prices and Inventories On Request

NEW DRILL PIPE

9600'—3½" O.D. x 13.85# J & L "Blue Ribbon" Drill Pipe with 4⅞" O.D. Integral Internal Flush Tool Joints.

LUCEY PRODUCTS CORPORATION
624 So. Cheyenne Phone 4-1144
Tulsa, Okla. LD 204

PETROLEUM ENGINEERS

Major oil company has openings for graduate Junior & Senior Petroleum Engineers in its operations in Venezuela. Salary commensurate with experience.

Please send details of exp. to:

P. O. BOX 35
BOWLING GREEN STATION
NEW YORK 4, N. Y.

HELP WANTED

PETROLEUM GEOLOGIST

Wanted for Staff position in growing independent oil company in West Texas. Must be man of mature age and judgment with at least ten years of practical and successful oil finding experience in exploration and development geology. Should have administrative ability to organize and supervise the work of two or more district geological offices. Salary will be commensurate with experience and abilities. Preferable age limits 35 to 45. In replying please give complete personal and professional background and references. Small recent photo would be helpful. All applications will be treated in utmost confidence, but personal interview will be arranged only if data furnished is adequate and meets our requirements. Box H-691, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED, MANAGER OF FOREIGN DRILLING OPERATION

Oil well drilling contractor has immediate opening for drilling engineer in Africa. Single status job with liberal salary and bonus.

Drilling & Exploration Company, Inc.
P. O. Box 2—Station "H"
Los Angeles 44, California.

ESTIMATOR

Experienced in process equipment and piping costs for chemical plant and refinery construction. Position offers good future with progressive Penna. firm. Send resume to—

J-65, P. O. BOX 3575
PHILA., 22, PA.

PETROLEUM ENGINEER

for patent liaison work, preferably with field experience. The work involves evaluation of ideas and data, accurately describing and delineating inventions, advising patent attorneys on technical questions, and collaborating with attorneys and inventors in the preparation of patent applications. The position, at a large integrated petroleum research laboratory, affords contact with various aspects of drilling and production. Write

BOX H-686,
THE OIL AND GAS JOURNAL,
TULSA, OKLAHOMA.

EQUIPMENT ENGINEER

To review and prepare specifications, standards and inspection procedures for drilling, producing and exploration equipment and supplies. For Equipment Engineering Division located in New York City.

Must have Petroleum or Mechanical Engineering degree together with experience in the manufacture, use and maintenance of drilling and exploration equipment and supplies.

Salary commensurate with education and experience. Write giving full particulars regarding personal history and work experience. Please include telephone number.

Recruiting Supervisor, Box 41

ARABIAN AMERICAN OIL COMPANY
505 Park Avenue
New York 22, N. Y.

HELP WANTED

TOOLPUSHER, Abilene, Texas area capable handling Drilling Supt. duties later. Also may participate profit sharing plan. Must have varied West Texas experience. Write Letter giving experience, references, education, age, etc. Box H-708, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOPHYSICAL SUPERVISOR, foreign experience preferable, by established contract Seismograph Company. Dallas organization. Salary commensurate with experience. Give full qualifications and references. Maximum Age 50. Box H-688, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEERS

Petroleum engineers wanted by producing department of large independent company. Must have four or more years' practical experience in Texas or Oklahoma, and college degree. Age 28-38. Assignments will include reservoir analysis and general production engineering. Send recent employment record and college transcript. Our employes have been advised. Replies confidential.

Box H-719
The Oil and Gas Journal
Tulsa, Oklahoma

Major Oil Co. Has Opening For A CORROSION & MATERIALS ENGR.

Should be 40 or under with 5-10 years exp. in oil refinery corrosion and metallurgical work.

GOOD WORKING CONDITIONS
EXCELLENT BENEFITS
ATTRACTIVE COMPENSATION
Position in NYC area.
Send full particulars to

BOX H-704,
THE OIL AND GAS JOURNAL,
TULSA, OKLAHOMA

REFINERY ENGINEERS

for MAJOR OIL COMPANY. Several openings for Chemical, Mechanical and Civil Engineers in the following fields:

- **Process Design**
- **Refinery Technical Service**
- **Product Quality Control & Development**
- **Refinery Design and Project Engineering**
- **General Engineering of Refinery Plants**
- **Refinery Utilities Engineering**

Candidates should meet the following requirements:

- **3 or more years experience in any of above listed fields.**
- **Draft exempt.**
- **Interested in possibility of future overseas service.**
- **Bachelor's or Master's degree in Engineering from recognized technical college or university.**

Salary commensurate with background and experience. Complete employee benefits plans.

Send detailed résumé to:

Box H-690, The Oil and Gas Journal
Tulsa, Oklahoma

HELP WANTED

EXPERIENCED MAN to take complete charge dismantling Oil Refineries. Knowledge in handling usable and scrap materials. Box H-687, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Junior Petroleum Engineer for Oil Tool Co., Inc. P. O. Box 7288, Houston 8, gas lift sales and Engineering work. Macco Texas.

GRADUATE GEOLOGIST, under 30, needed immediately for established independent oil company. No experience necessary. P. O. Box 2775, Dallas, Texas.

ACCOUNTANT: Excellent opportunity for man with college training and working knowledge of oil field materials in Dallas office of independent oil producer. P. O. Box 2775, Dallas, Texas.

PETROLEUM ENGINEERS

Major oil company has openings for graduate Petroleum Engineers in its operations in Venezuela. 1½ to 4 years experience required. Salary commensurate with experience. Liberal company benefit plans. Send complete resume of work experience to

Box H-724
The Oil and Gas Journal
Tulsa, Oklahoma

PETROLEUM SALESMAN

Interested in Opportunity

Long established and leading manufacturer and distributor of petroleum testing and laboratory equipment offers "lifetime opportunity." We ars seeking Chem. Engineer, or equivalent, with refinery, refinery laboratory, or petroleum products sales experience.

Position is ground floor opportunity in new division offering personal and financial success. Salary, commission, and expenses included in compensation arrangements. Mid-west, or East and West Coast assignment after initial training in Chicago.

Your application for this career opportunity will be considered fully and confidentially. Include small photo, if available, in your detailed reply of personal and professional qualifications. Interviews will be conducted locally, and arranged for mutual convenience.

BOX H-614,
THE OIL AND GAS JOURNAL
TULSA, OKLAHOMA

PETROLEUM GEOLOGISTS

Important Petroleum Organization offers the following interesting opportunities involving research, compilation and preparation of geological data and reports on foreign operations:

For New York:

One Senior, with advanced degree, at least five years field mapping experience and possessing broad interests in petroleum geology of foreign countries.

One Junior, M.S. degree or equivalent with/without experience, interested in foreign assignment as opportunity becomes available.

Foreign:

Seniors and Juniors, for foreign field mapping assignments; M.S. degree or equivalent. Seniors must have field mapping experience.

All applicants submit qualifications in detail.

BOX H-718
THE OIL AND GAS JOURNAL
TULSA, OKLAHOMA

HELP WANTED

FOREIGN EMPLOYMENT. List of oil companies and drilling contractors showing where to apply for foreign jobs. OIML Co., Box 2603, Tulsa, Okla. $5.00 cash.

OFFICE MAN WANTED BY SUPPLY COMPANY. Must be capable of writing specifications for complete drilling rigs. Graduate Petroleum Engineer preferred. Established, well-known company in the Midwest. Send background and complete information to Box H-716, The Oil and Gas Journal, Tulsa, Oklahoma.

PROCESS ENGINEER with thorough technical training and background of engineering and operating experience with special emphasis on catalytic and thermal reforming, alkylation, and petrochemicals. Send complete record of education, experience, and minimum salary expected. Write Box H-723, The Oil and Gas Journal, Tulsa, Oklahoma.

LAND MAN: Independent operating primarily in Texas and Louisiana desires land man with at least 3 years experience particularly in administrative (as distinguished from trading) aspects of land work. Legal training desired but not essential. Give detailed personal and employment history in first letter. Our employees know of this advertisement. Box H-721, The Oil and Gas Journal, Tulsa, Oklahoma.

CHIEF ENGINEER

We offer an immediate opening with one of the industry's oldest and largest manufacturers of oil field producing equipment.

Must have a degree in mechanical or petroleum engineering; three or more years experience in supervising a department; three or more years field experience in the installation and operation of producing equipment; and at least an "engineering experience" with welding shop operations and procedures.

Must have a sound knowledge of thermodynamics as applied to the design of combustion equipment, heat exchangers, emulsion treaters, dehydrators, etc., as well as the know-how to design process and oil field production equipment.

Write and give full details of personal history and work experience and, if possible, include a photograph.

Box H-684, The Oil and Gas Journal, Tulsa, Oklahoma.

JOB ENGINEERS
Mechanical or Chemical

SAN FRANCISCO
Assignment

Recent design experience on petroleum refineries or chemical plants. Assignment requires thorough knowledge of heat exchangers, pumps, piping layouts, specification work, and analysis of bids. Compensation commensurate with ability. Please write furnishing complete chronological experience record and salary history, also full details regarding education, salary required, business and character references.

BECHTEL CORPORATION
220 Bush Street
San Francisco 4, Calif.

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Delaware Corporations formed and serviced. American Guaranty & Trust Company, P. O. Box 487, Wilmington, Delaware.

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SEVERAL HUNDRED validated uranium claims available for sale or farmout proposition to responsible parties. Proven ore bodies, claims with mining in process or exploration properties. Located in Gas Hills area, Fremont County, Wyoming and Colorado Plateau area. Inquiries of substance given prompt attention. Write P. O. Box 626, Casper, Wyoming.

OIL FORMS

KRAFTBILT FORMS, designed especially for the oil industry, are popular because they are efficient, economical. For plat sheets, well log strips, columnar pads, all production reporting forms, material transfers, truck reports, all administrative forms, ask for new Catalog 1154-K. Ross-Martin Co., P. O. Box 800-A, Tulsa 1, Oklahoma.

HELP WANTED

MANAGERIAL PERSONNEL NEEDED

For Research Centre in The Petroleum Industry

Ente Nazionale Idrocarburi (E.N.I.) has under its supervision a number of Italian Companies active in the field of petroleum and petrochemicals. ENI's major activity is centered in the following items:

- gas and oil field exploration and exploitation (current production: 105 billion cu. ft. of natural gas per year);
- operator of a 2500-mi. pipe-line system (capacity over 700 million cu. ft. per day);
- owner and operator of a tanker fleet of around 120.000 dwt;
- owner and operator of an extensive network for distribution of petroleum products and LP-gas throughout Italy (64 Bulk plants, 4000 stations, etc.);
- control over or shareholding in refineries having a processing capacity of about 6 million tons of crude oil per year;
- owner of factories (1500 employees) for construction of machinery;
- shareholding of chemical plants (700 employees) for production of synthetic dyes, detergents, etc.;
- under construction, a petrochemical plant (production capacity—30.000 tons per year of synthetic rubber and 350.000 tons per year of ammonium nitrate).

E.N.I. is organizing a big research center for investigation and development of petroleum processing and manufacture of petrochemicals. Some departments are expected to begin operation next summer.

Italian or foreign technical experts, with a wide educational background, specific training, organizational and managerial ability, are required to fill positions as heads of the main departments of the laboratories.

Specifically the following are sought:

1) Chemist or physicist with specific knowledge and experience in thermodynamic and chemico-physical problems;
2) Chemist specialized in the preparation of organic compounds particularly those derived from hydrocarbons;
3) Inorganic chemist soundly and completely acquainted with modern methods of experimentation, research and testing;
4) Engineer or industrial chemist specially trained in the methods for improving petroleum products applications;
5) Engineer or physicist, with physico-technical and technological training, specialized in the problems of thermo-technics, measurements and controls;
6) Engineer or industrial chemist with extensive research experience in the field of crude oils processing;
7) Engineer or industrial chemist particularly experienced in extending laboratory procedures to pilot plants;
8) Engineer with good theoretical knowledge and laboratory experience in engine tests on fuels and lubricating oils;
9) Engineer or industrial chemist specially trained both in theory and practice in the fields of corrosion and protective means for materials.

Note: University degree mandatory.

Applications should state age and other usual personal data, educational background and qualifications, practical experience, etc. and should include a photograph. Please address personally to the: **Presidente dell'Ente Nazionale Idrocarburi, Via Lombardia, 43 - Roma - Italy,** with the special note **RISERVATA PERSONALE** (i.e., to be opened by addressee only).

Absolute discretion in every respect is assured.

Salary offered will be in accordance with position, training and qualities required.

SITUATIONS WANTED

GEOLOGIST, 31. Master's, five years Major company experience in Texas, Kansas, Oklahoma and Colorado, desires position in Denver area. Box H-728, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEER, 32, graduate, 5 years engineering experience in drilling and production with major company in West Texas. Desire change to independent in Oklahoma or East Texas. Box H-726, The Oil and Gas Journal, Tulsa, Oklahoma.

SUBSURFACE GEOLOGIST: 4 years experience Geophysics and Subsurface Geology in South America, single, 28, desire domestic or foreign work, willing to travel. Box H-720, The Oil and Gas Journal, Tulsa, Oklahoma.

Well organized, well established oilwell drilling contractor desires the management and supervision of oil properties in West Texas, Central Texas, and New Mexico. Can provide complete handling of oil properties, from acquisition to production. No properties too small, and none too large to handle. Inquiries from independents, groups, small or medium sized oil companies invited. Write, wire, or call collect for further information.

MAKIN DRILLING COMPANY
P. O. Box 1628, Hobbs, New Mexico
Phone 3-3141.
146 Allen Building, Midland, Texas.
Phone 2-2962.

SITUATIONS WANTED

DRILLING AND PRODUCTION Superintendent, 42, 15 years varied experience, location open. Box H-701, The Oil and Gas Journal, Tulsa, Oklahoma.

CHEMICAL ENGINEER, 6 years refinery engineering and operating experience, includes major catalytic processes. Box H-730, The Oil and Gas Journal, Tulsa, Oklahoma.

DRILLING AND PRODUCTION MAN. A man of mature age and judgment, with good sound technical thinking, 18 years varied experience in drilling and production, desires position with Independent Company or Drilling Contractor, best of references. Box H-709, The Oil and Gas Journal, Tulsa, Oklahoma.

30 YEAR OLD ATTORNEY, Federal and Kansas courts, 150,000 ft. roughneck experience, clerical ability, ex-marine free to travel, seeks career employment with drilling-producing firm. Box H-722, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOPHYSICIST. 20 Years with major and small oil company in North, Central, South America, Far East, Europe. Seismic gravimetric interpretations, geophysical-geological exploration. Master's degree. Prefers position in geophysical department of oil company. Box H-725, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST presently employed in Oklahoma City by major company, 6½ years experience seismic, subsurface, electric log correlation and well sitting in Permian basin, Rocky Mountains, and Oklahoma. Desires to work for a smaller organization. Box H-729, The Oil and Gas Journal, Tulsa, Oklahoma.

SITUATIONS WANTED

GEOPHYSICIST DESIRES POSITION: For the past three years I have supervised Gulf's reflection and refraction seismic interpretation associated with the following discoveries: Buick Creek in British Columbia; Braeburn, Thunder Lake, Little Smoky and Clear Hills in Alberta; Frobisher in Saskatchewan. For the past eight months I have supervised all refraction interpretation in the Alberta Foothills from Pincher Creek, north. I have also served as advisor on the use of magnetic and gravity results in the overall exploration effort in Western Canada. J. L. Robinson, 1720 Eleventh Street, SW, Calgary, Alberta, Canada; age 38; Graduate Carnegie Institute of Technology.

ROYALTIES

PIPELINES ANNOUNCED: Projected pipelines indicate increasing action in central Williston Basin, where we specialize in royalties in major company blocks. For informative material, write LANDOWNERS ROYALTIES COMPANY, Box 1225, Great Falls, Mont.

NEW CUSTOMERS SOLICITED. You can now make very small investments on income Royalties or those ahead of Drilling. A. S. Berry, P. O. Box 1383, Tulsa, Okla.

OFFERING CHOICE PRODUCING oil income royalties with large reserves per Dollar invested. A. S. Berry, P. O. Box 1383, Tulsa, Okla.

JACK EAGLE, Oil Properties, 706 City Nat'l. Bldg., Oklahoma City, Oklahoma, Telephone REgent 6-7027.

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NEW PRODUCTS for license, outright sale, or franchise. Monthly digest—$1.00. Ten dollars annually. Digest D1, Box 2052, Austin, Texas.

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Will pay cash instantly for lease (large blocks), royalties, mineral deeds, production. Write fully—P. O. Box 2153, Denver, Colorado.

CONTACT A. L. Bowles, Box 947, Ada, Okla., for Drilling Deals, Oil Investments.

ATTRACTIVE DRILLING deal on potential gas acreage in North Collingsworth County, Texas—Panhandle Field Extension—One mile from production—2000 feet deep—Large reserve—Reasonably priced. Box H-712, The Oil and Gas Journal, Tulsa, Oklahoma.

LEASES ROYALTIES

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Bought and Sold—Any Area

Inquiries Invited

B. D. BUCKLEY

6635 Delmar Ave., St. Louis, Mo.

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125 sections New Mexico, 60 mi. SW Hartley Co., Tex. Combined oil, gas & uranium, solid block, one owner. Well drilled 1926. Would be producer now under modern drilling technique. Have log and maps. Several known URANIUM deposits. PRICE: $1.50 per acre bonus, 50c rentals, net to owner, 10 year commercial lease.

COMBEST ROYALTY COMPANY

Amarillo, Texas

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SET OF Oklahoma Completion Cards. Rinehart or Research. State number of years available and price. Box 1104, Tulsa.

WANTED—IDEAS

Inventions that are related or can be adapted to the oil industry. We offer capital, technical advice, patent assistance, market research, a manufacturing plant, and a sales outlet; everything to put your invention on the market. Write P. O. Box 1665, Houston 1, Texas.

SETTLED OIL production wanted by independent operator direct from producer. P. O. Box 852, Oklahoma City, Oklahoma.

WESTERN CANADA—Manufacturers Representation—Graduate Mechanical Engineer—desires accounts for sale to oil, gas industries; refineries, pipelines. Excellent contacts. Box H-695, The Oil and Gas Journal, Tulsa, Oklahoma.

REAL ESTATE

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LOUISIANA PARADISE — Agriculture — Cattle — Wild Game — 3000 Acres most fertile delta land in south. 3 bales cotton per acre. Cattle, natural year round range. Wild deer, turkey, squirrels and ducks. Thirty - forty thousand dollars merchantable timber. Thirty miles of fence. Good oil possibilities. Not leased. Quick sale, $75.00 per acre. Full description, write—Dr. N. E. Wilson, Homer, La.

GRAYSON COUNTY, TEXAS. For Lease: Offices—Warehouse—Unimproved sites with or without rail siding. Munson Realty Co., Denison, Texas.

Buy or Rent a cottage on Mount Desert Island, one of the most beautiful spots in the world. Shore cottage at Seawall, 8 rooms, 5 bedrooms, 4 baths, fireplace, modern kitchen, 2-car garage. Completely furnished. Cost $35,000 in 1947. Sale price $22,500. Season's rental $1600. Write for list of other properties.
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March 24, 1955

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LEGAL

Sealed bids will be received until April 20, 2:00 P.M., Mountain Standard Time, and opened at that time in the Office of the Superintendent, Fort Belknap Consolidated Agency, Harlem, Montana, for the leasing of 2,553.88 acres of Tribal land and 32,826.49 acres of allotted Indian land located in Township 28 N. R. 23 E., Township 28 N. R. 24 E., Township 29 N. R. 23 E., Township 30 N. R. 24 E. and Township 31 N. R. 24 E. Blaine County, Montana, for oil and gas mining purposes. The details of the lease offering and how and where to file bids may be obtained by addressing the inquiry to the Superintendent of the Fort Belknap Consolidated Agency, at Harlem, Montana (Telephone 5-R-4.).

LEGAL

U. S. DEPARTMENT OF THE INTERIOR Bureau of Land Management, Washington 25, D. C. Notice is hereby given that 124.92 acres of land within the known geologic structure of the East Greenwood field, Louisiana, will be offered for oil and gas leasing through competitive bidding to the qualified bidder of the highest cash amount per acre at 1:00 p.m., E.S.T., April 27, 1955, when bids will be opened. Details of the lease offering, description of the lands, how and where to submit bids, and bid forms may be obtained from the Supervisor, Eastern States Office, Bureau of Land Management, Washington 25, D. C. C. R. Drexilius, Supervisor.

LEGAL

SEALED BIDS will be received until 10:00 A.M. Wednesday, April 13, 1955, and opened at that time at the Anadarko Area Office for the leasing of allotted and tribal Indian lands located in Tillman, Grady, Cotton, Comanche and Caddo Counties, Oklahoma, for oil and gas mining purposes. For additional information write or telephone Mr. Hayes, Oil and Gas Division of the Anadarko Area Office (Phone 788).

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